C.S.I.R.O.

1959-60

COMMONWEALTH SCIENTIFIC & INDUSTRIAL RESEARCH ORGANIZATION

TWELFTH ANNUAL REPORT

COMMONWEALTH MYCOLOGICAL
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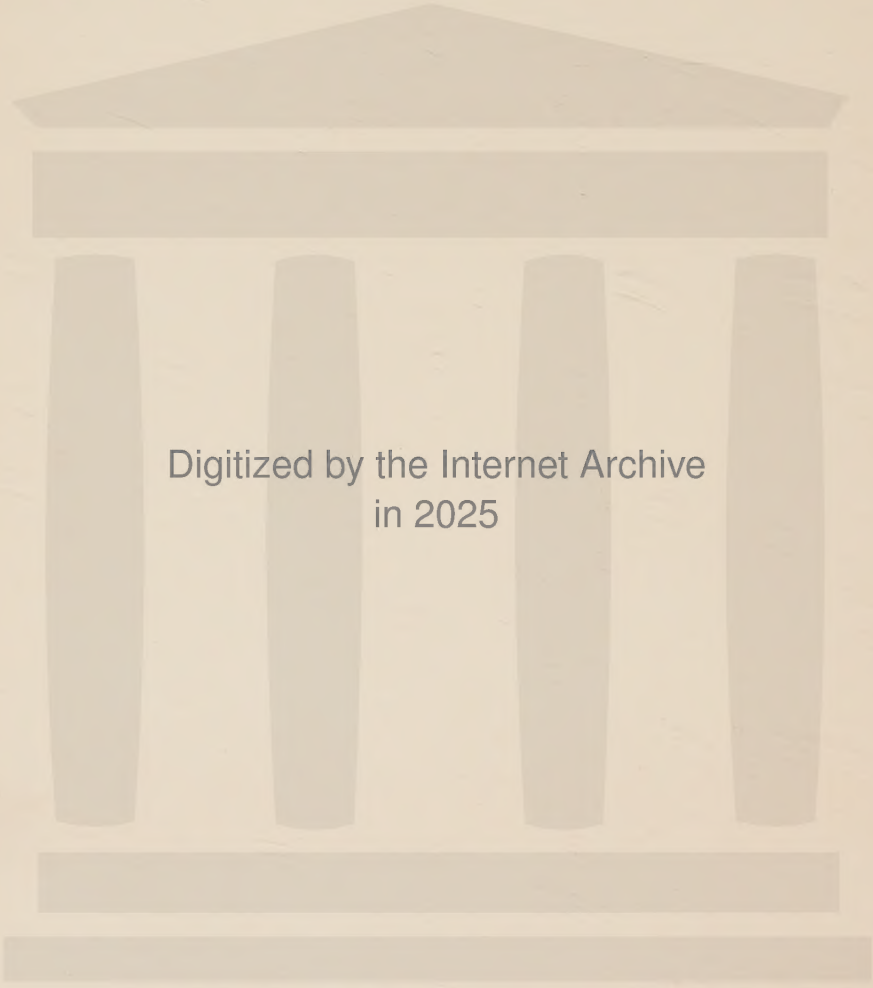

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Twelfth Annual Report of the Commonwealth Scientific & Industrial Research Organization

FOR THE YEAR ENDING 30TH JUNE, 1960

COMMONWEALTH OF AUSTRALIA

Printed by C.S.I.R.O., Melbourne

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To enable the Annual Report of the Organization to be prepared in time for its presentation to Parliament early in the 1960 budget sitting, it has been necessary to modify its form. The chapters describing detailed technical matters that previously formed the major part of the Annual Report have been replaced by a brief account of the more important developments that have occurred during the year. Full details of the progress made in the research programmes of the Divisions and Sections will be published separately as a Research Review.

The Executive expresses its gratitude to the many Government Departments, Universities, other organizations, and individuals for their help in providing laboratory accommodation and other facilities, and in many other ways. The assistance of the various C.S.I.R.O. committees, whose members have made their knowledge and experience so freely available, is also gratefully acknowledged.

I

General Review

The Science and Industry Research Act, 1949, under which the Commonwealth Scientific and Industrial Research Organization was established, has been amended in a new Act which received assent on December 1, 1959.

The Science and Industry Research Act, 1959, provides for the appointment of five full-time members of the Executive and four part-time members. At least five members of the Executive must be scientists. The names of the members of the Executive are listed on page 2.

The powers and functions of C.S.I.R.O., which are the same as those specified in the earlier Act, are:

the initiation and carrying out of scientific researches and investigations in connexion with, or for the promotion of, primary or secondary industries in the Commonwealth or in any Territory of the Commonwealth or in connexion with any other matter referred to the Organization by the Minister;

the training of scientific research workers and the establishment and awarding of scientific research studentships and fellowships;

the making of grants in aid of pure scientific research;

the recognition or establishment of associations of persons engaged in any industry for the purpose of carrying out industrial scientific research and the cooperation with, and the making of grants to, such organizations when recognized or established;

the testing and standardization of scientific apparatus and instruments and the carrying out of scientific investigations connected with the standardization of apparatus, machinery, materials, and instruments used in industry;

the collection and dissemination of information relating to scientific and technical matters;

the publication of scientific and technical reports, periodicals, and papers;

acting as a means of liaison between the Commonwealth and other countries in matters of scientific research.

Minister-in-Charge of C.S.I.R.O.

The Right Honourable Lord Casey, P.C., C.H., D.S.O., M.C., M.A., has become the first Australian to be awarded a life peerage. By his resignation from Parliament, Lord Casey has concluded a long period of ministerial responsibility for C.S.I.R. and C.S.I.R.O. dating back to 1937. Lord Casey will continue his association with the Organization as a part-time Member of the Executive.

Doctor the Honourable D. A. Cameron, O.B.E., B.A., M.B., B.S., M.P., has been appointed Minister-in-Charge of C.S.I.R.O. following the resignation of Lord Casey. Dr. Cameron, who has been Minister for Health since 1956, was previously associated with the Organization as Acting Minister-in-Charge of C.S.I.R.O. during Lord Casey's absence overseas last year.

Executive

Dr. F. W. G. White, C.B.E., M.Sc., Ph.D., F.A.A., formerly Deputy Chairman, was appointed Chairman as from July 1, 1959.

Dr. R. N. Robertson, B.Sc., Ph.D., F.A.A., formerly Chief Research Officer, Division of Food Preservation and Transport, has been appointed a full-time Member of the Executive for a period of 3 years.

Mr. C. S. Christian, B.Agr.Sc., M.S., formerly Chief, Division of Land Research and Regional Survey, has been appointed a full-time Member of the Executive for a period of 5 years.

Emeritus Professor L. G. H. Huxley, M.A., D.Phil., Ph.D., F.A.A., formerly Elder Professor of Physics, University of Adelaide, has been appointed a full-time Member of the Executive for a period of 7 years.

The Right Honourable Lord Casey, P.C., C.H., D.S.O., M.C., M.A., formerly Minister-in-Charge of C.S.I.R.O., has been appointed a part-time Member of the Executive for a period of 3 years.

Mr. E. P. S. Roberts, a prominent Queensland grazier, has been appointed a part-time Member of the Executive for a period of 3 years.

The complete list of the Members of the Executive is now:

Dr. F. W. G. White, C.B.E., M.Sc., Ph.D., F.A.A. (*Chairman*)
Dr. S. H. Bastow, D.S.O., B.Sc., Ph.D.
Mr. C. S. Christian, B.Agr.Sc., M.S.
Emeritus Professor L. G. H. Huxley, M.A., D.Phil, Ph.D., F.A.A.
Dr. R. N. Robertson, B.Sc., Ph.D., F.A.A.
Sir Arthur Coles, Kt.
Dr. J. Melville, M.Sc., Ph.D.
Rt. Hon. Lord Casey, P.C., C.H., D.S.O., M.C., M.A.
Mr. E. P. S. Roberts.

Advisory Council

The following members retired from the Advisory Council during the year:

Mr. E. P. S. Roberts (Appointed Member of the Executive)

Dr. L. B. Bull, C.B.E., D.V.Sc., F.A.A.

Mr. D. R. Hawkes

Mr. W. W. Pettingell, O.B.E., B.Sc.

Mr. W. J. Russell, A.C.I.A.

Professor J. G. Wood, Ph.D., D.Sc., F.A.A. (Chairman, South Australian State Committee) died during the year.

The following new members have been appointed to the Council:

Sir Lionel Hooke, Kt., S.M.I.R.E. (Amer.), F.I.R.E. (Aust.) (coopted)

Mr. E. H. Lee-Steere (coopted)

Emeritus Professor Sir Samuel Wadham, Kt., M.A., LL.D., Agr.Dip. (coopted)

Mr. H. P. Weber, M.Sc., F.R.A.C.I., M.I.Chem.E., F.A.I.M. (coopted)

Mr. E. M. Schroder (Chairman, South Australian State Committee)

Dr. W. A. T. Summerville, D.Sc. (coopted)

Mr. P. Ryan, B.Agr.Sc. (coopted)

Professor C. M. Donald, M.Ag.Sc., H.D.A. (coopted).

Secretariat

The structure of the Secretariat was reorganized during the year under review.

Mr. G. B. Gresford, B.Sc., A.R.M.T.C., has been designated Secretary of C.S.I.R.O. He is now responsible for the administrative machinery of the Organization, with the exception of financial matters which will continue to be the responsibility of Mr. M. G. Grace, A.A.S.A., Secretary (Finance and Supplies).

Mr. W. Ives, M.Ec., has been designated Executive Officer, and he assists the Executive on policy matters relating to the agricultural and biological sciences.

Honours and Awards

The Queen's Birthday Honours List for 1960 included:

Sir Arthur Coles, a Member of the Executive, who was made a Knight Bachelor.

Dr. B. T. Dickson, a former Chief of the Division of Plant Industry, who was made a Companion of the Order of Saint Michael and Saint George.

Professor N. S. Bayliss, Chairman of the Western Australian State Committee, who was made a Commander of the Order of the British Empire.

Officers of C.S.I.R.O. who received honours and awards during the year under review were:

Dr. F. W. G. White, Chairman: Fellow, Australian Academy of Science.

Dr. R. N. Robertson, Member of the Executive: President, Australian Society of Plant Physiologists.

Dr. I. W. Wark, Director, Chemical Research Laboratories: Honorary Membership, Australasian Institute of Mining and Metallurgy. Dr. Wark was also invited to deliver the Sir Julius Wernher Memorial Lecture at the International Mineral Processing Congress.

Dr. J. R. Vickery, Chief, Division of Food Preservation and Transport: 1960 International Award, Institute of Food Technologists, U.S.A.

Dr. O. H. Frankel, Chief, Division of Plant Industry: Member of the Council, Australian National University, and Fellow, Australian Institute of Agricultural Science.

Dr. J. M. Rendel, Chief, Division of Animal Genetics: Fellow, Australian Academy of Science.

Dr. W. Boas, Chief, Division of Tribophysics: Silver Medal, Australian Institute of Metals.

Dr. D. F. Martyn, Officer-in-Charge, Upper Atmosphere Section: Invited to deliver the first "A.B.C. Lectures" by the Australian Broadcasting Commission.

Dr. G. D. Aitchison, Officer-in-Charge, Soil Mechanics Section: Member, Institution of Engineers, Australia.

Dr. A. B. Edwards, Officer-in-Charge, Mineragraphic Investigations: Clarke Medal, Royal Society of New South Wales.

Dr. A. Walsh, Chief Research Officer, Division of Chemical Physics: Doctor of Science, University of Manchester.

Dr. C. G. Stephens, Senior Principal Research Officer, Division of Soils: Verco Medal, Royal Society of South Australia.

Mr. A. J. Vasey, Senior Principal Research Officer, Division of Animal Health: Fellow, Australian Institute of Agricultural Science.

Mr. A. F. A. Harper, Senior Principal Research Officer, Division of Physics: President, Royal Society of New South Wales.

Dr. D. O. Norris, Senior Principal Research Officer, Division of Tropical Pastures: Australian Medal of Agricultural Science, Australian Institute of Agricultural Science.

Dr. D. E. Weiss, Senior Principal Research Officer, Division of Physical Chemistry: Doctor of Science, University of Adelaide.

Dr. D. Martin, Officer-in-Charge, Tasmanian Regional Laboratory: Vice-President, Royal Society of Tasmania.

Mr. R. F. Riek, Principal Research Officer, Division of Animal Health: Doctor of Veterinary Science, University of Queensland.

Dr. G. F. Walker, Principal Research Officer, Cement and Refractories Section: Doctor of Science, University of Aberdeen.

Mr. W. M. McKenzie, Senior Research Officer, Division of Forest Products: 1960 Wood Award, Forest Products Research Society, U.S.A.

Mr. E. Munch-Petersen, Senior Research Officer, Division of Animal Health: Silver Medal, Australian Society of Dairy Technology.

Dr. R. O. Slatyer, Senior Research Officer, Division of Land Research and Regional Survey: Doctor of Science in Agriculture, University of Western Australia.

Mr. G. W. West, Senior Research Officer, Division of Tribophysics: 1960 Florence Taylor Award, Australian Institute of Metals.

Dr. C. A. Appleby, Research Officer, Division of Plant Industry: Fellowship, Rockefeller Foundation.

The late Dr. C. S. Gum, Research Officer, Division of Radiophysics: Fellowship, Carnegie Institute.

Dr. J. R. Philip, Principal Research Officer, Division of Plant Industry: Doctor of Science, University of Melbourne.

Dr. J. P. Funk, Research Officer, Division of Meteorological Physics: Durton Prize, Royal Meteorological Society.

Miss B. Doubleday, Chief Librarian: Vice-President, Library Association of Australia.

Mr. E. Bez, Apprentice Instrument Maker, Division of Chemical Physics: Bronze Medal, Apprenticeship Commission of Victoria.

Professorships

Dr. L. G. H. Huxley, M.A., D.Phil, Ph.D., F.A.A., a Member of the Executive, has been awarded the title of Emeritus Professor by the University of Adelaide, in recognition of his service as Elder Professor of Physics at the University of Adelaide.

Dr. R. N. Robertson, B.Sc., Ph.D., F.A.A., a Member of the Executive, has accepted an invitation to fill the Chair of Botany at the University of Adelaide, but he will not take up this appointment until early in 1962.

Dr. W. N. Christiansen, D.Sc., F.A.A., Senior Principal Research Officer, Division of Radiophysics, has been appointed Professor of Electrical Engineering at the University of Sydney.

Dr. G. R. A. Ellis, B.Sc., Ph.D., Senior Research Officer, Upper Atmosphere Section, has been appointed Professor of Physics at the University of Tasmania.

Dr. E. A. Cornish, B.Agr.Sc., D.Sc., F.A.A., Chief, Division of Mathematical Statistics, has accepted an invitation to fill the newly created Chair of Mathematical Statistics at the University of Adelaide. Dr. Cornish will retain his position with the Organization.

Dr. D. G. Lampard, M.Sc., Ph.D., Senior Research Officer, Division of Electrotechnology, has been appointed Professor of Communication Engineering at the University of New South Wales.

Organizational Changes

Animal Research Laboratories

The Division of Animal Health and Production has been reorganized as three new Divisions which collectively form the Animal Research Laboratories:

Division of Animal Genetics, of which Dr. J. M. Rendel, B.Sc., Ph.D., F.A.A., has been appointed Chief. This Division includes: the former Animal Genetics Section, Sydney; the National Field Station, Cunnamulla, Qld.; the National Cattle Breeding Station, Rockhampton, Qld.; the Poultry Research Centre, Werribee, Vic.; the F. D. McMaster Field Station, Badgery's Creek, N.S.W.; and the animal breeding section at the McMaster Laboratory, Sydney.

Division of Animal Health, of which Dr. T. S. Gregory, D.V.Sc., Dip. Bact., has been appointed Chief. This Division includes: the Animal Health Laboratory, Parkville, Vic.; the McMaster Animal Health Laboratory, Glebe, N.S.W.; the Veterinary Parasitology Laboratory, Yeerongpilly, Qld.; together with their associated field stations.

Division of Animal Physiology, of which Dr. I. W. McDonald, B.V.Sc., B.Sc., Ph.D., has been appointed Chief. This Division includes: the Ian Clunies Ross Animal Research Laboratory, Prospect, N.S.W.; and the Regional Pastoral Laboratory, Armidale, N.S.W., with its associated "Chiswick" field station, Armidale, N.S.W.

Division of Coal Research

The former Coal Research Section at North Ryde, N.S.W., has now been designated the Division of Coal Research with Mr. H. R. Brown, B.Sc. (Eng.) (Hons.), as Chief of the Division.

Cement and Refractories Section

The name of the former Cement and Ceramics Section of the Chemical Research Laboratories, Fishermen's Bend, Vic., has been changed to Cement and Refractories Section. Mr. A. J. Gaskin, M.Sc., is Officer-in-Charge of the Section.

Coastal Plains Research Station

The name of the former Rice Research Station, near Darwin, has been changed to Coastal Plains Research Station. The Director of the Station is Mr. K. Wilson-Jones, B.Sc. (Hons.), M.Sc.

Mathematical Instruments Section

The former Mathematical Instruments Section at the Department of Electrical Engineering, University of Sydney, has now been disbanded.

Retirements and Resignations

Mr. D. A. Gill, M.R.C.V.S., D.V.S.M., Chief of the former Division of Animal Health and Production, retired during the year. Mr. Gill had been an officer of

the Division since 1934, and played a major part in the development of research in Australia for the livestock industries. Instead of appointing a successor to Mr. Gill, the Executive decided to split the former Division into three Divisions (*see* page 6).

Dr. A. J. Nicholson, D.Sc., F.A.A., retired as Chief of the Division of Entomology. Dr. Nicholson was Chief of the Division for 27 years and has made notable contributions to research in the study of insect populations. Dr. Nicholson will not be severing his association with the Organization, having accepted a Senior Research Fellowship to continue his investigations on population dynamics.

Dr. K. L. Sutherland, Ph.D., D.Sc., F.A.A., resigned as Chief of the Division of Physical Chemistry of the Chemical Research Laboratories, Fishermen's Bend, Vic., to accept appointment as Director of Research, Colonial Sugar Refining Co. Ltd. A successor has not yet been appointed to replace him.

Professor D. M. Myers, B.Sc., D.Sc.Eng., resigned as Officer-in-Charge, Mathematical Instruments Section, to accept appointment as Dean of Applied Science, University of British Columbia, Canada.

New Chief, Division of Entomology

Dr. D. F. Waterhouse, D.Sc., F.A.A., has been appointed Chief of the Division of Entomology to succeed Dr. Nicholson. Dr. Waterhouse has been a senior member of the research staff of the Division since 1938 and was appointed Assistant Chief in 1953.

New Laboratories

Cunningham Laboratory

This laboratory, headquarters of the Division of Tropical Pastures, was officially opened in November 1959, by the Prime Minister, the Right Honourable R. G. Menzies, C.H., Q.C., M.P. The Laboratory, situated in the grounds of the University of Queensland, St. Lucia, is named after the explorer, Allan Cunningham, who discovered the Darling Downs and helped to establish the Brisbane Botanical Gardens. In addition to staff of the Division of Tropical Pastures, the Cunningham Laboratory houses research groups from the Divisions of Soils, Plant Industry, Entomology, and Mathematical Statistics.

Ian Clunies Ross Animal Research Laboratory

This laboratory, headquarters of the Division of Animal Physiology, at Prospect, N.S.W., was officially opened in March 1960, by the Right Honourable Lord Casey, P.C., C.H., D.S.O., M.C., M.A. The Laboratory has been named in memory of the former Chairman of the Organization, the late Sir Ian Clunies Ross. The Division of Animal Physiology is one of the three Divisions formed from the former Division of Animal Health and Production (*see* page 6). Its research programmes are part of the Organization's integrated investigations in aid of the sheep and wool industries.

Soil Mechanics Section

A laboratory situated at Syndal, Vic., was completed and occupied during the year. The new laboratory is a joint undertaking with the University of Melbourne and, in addition to the Section's staff, houses a small group of workers from the University's Department of Civil Engineering.

Bread Research Institute

A laboratory at North Ryde, N.S.W., which houses the staff of the C.S.I.R.O. Wheat Research Unit, was officially opened by Dr. the Honourable D. A. Cameron, O.B.E., B.A., M.B., B.S., M.P., Minister-in-Charge of C.S.I.R.O., in May 1960. The Institute was established in 1947, and is now supported by funds derived from the baking industry in all States and from a grant from the Organization. Mr. E. E. Bond, A.R.M.T.C., the Director of the Institute, is also Officer-in-Charge of the C.S.I.R.O. Wheat Research Unit.

Support for Research from the Primary Industries

Research programmes for the animal industries may be augmented by additional funds which are expected to become available as a result of legislation recently passed by the Commonwealth Government. This legislation has been framed after consultation with primary producers and is designed to provide continuing funds for research in specific fields.

Beef Cattle Research

The Australian Agricultural Council in collaboration with various bodies representing primary producers has been endeavouring to intensify research essential to the welfare of the beef industry.

As the result of negotiations with the Commonwealth Government, legislation has been passed which provided for establishment of a Beef Research Trust Account to which the industry will contribute from a levy on beef cattle and the Commonwealth Government through a grant on a £1 for £1 basis.

The Act also provides for the establishment of an Australian Beef Research Committee to administer the Trust Account, under the aegis of the Australian Meat Board.

Dairy Industry Research

Under the Dairy Produce Research and Sales Promotion Act, 1958, and the Dairy Produce Levy Act, 1958, a sum of approximately £300,000 is being raised. Of this half is being set aside for promotion purposes and half for research. The latter portion is being matched by a contribution from the Commonwealth Government, so that a sum of up to £300,000 will be available for research in the dairy industry.

Research programmes have been initiated by the Australian Dairy Produce Board with the assistance of the Dairy Produce Research Committee, which comprises representatives from the Australian Dairy Produce Board, the Department of Primary Industry, the Australian Agricultural Council, and the Organization.

Expenditure for the financial year 1959–60 has been under several main headings, which include:

Dairy Manufacturing Research.—This programme involves eight research groups in the Organization, State Departments of Agriculture, the University of Melbourne, the Queensland Agricultural High School and College, and the Queensland Butter Marketing Board. The Dairy Research Section of C.S.I.R.O. accepted responsibility for the development of fundamental research in flavour chemistry, milk proteins, and microstructure of dairy products, and for both fundamental and applied research in a wide range of dairy manufacturing problems. The total allocation of funds for dairy manufacturing research for 1959–60 was approximately £70,000, of which the Organization's share was £46,000.

Dairy Farm Research.—The wide range of problems under this heading led the Australian Dairy Produce Board to proceed more slowly in allocating funds. The 1959–60 allocations totalled approximately £65,000 and supported research into problems of particular importance to the industry. The programme involved 12 research groups including C.S.I.R.O., State Departments of Agriculture, and universities, and the allocation of funds to C.S.I.R.O. was £5400.

Studentships.—The expansion of dairy research and the growing technical demands of the industry have created a need to attract more graduates to this field. The Australian Dairy Produce Board has provided approximately £10,000 in the current year for a number of studentships (*see* page 16).

Australian Pastoral Research Trust

As a result of an offer received by the Organization from a group of graziers, the Executive has taken action to establish the Australian Pastoral Research Trust as a non-profit-making company to help the pastoral industries in the provision of animals for experimental purposes, and to assist the Organization generally in relation to pastoral research.

The Trust has now been incorporated as a company limited by guarantee under licence from the Attorney-General of the State of Victoria directing that the company be incorporated without the addition of the word "limited" to its name.

The following persons have been appointed as Directors of the Trust:

A. R. Beggs, "Buln Gherin", Beaufort, Vic.
D. W. Bucknell, "Quambone Station", Quambone, N.S.W.
R. R. Crossing, "Burta Station", Cockburn, S.A.
G. A. Dick, "Mt. Vernon", Melton Mowbray, Tas.
W. A. Gunn, 35 Junction Road, Clayfield, Qld.
D. R. Hawkes, "Moorara", Naracoorte, S.A.
E. H. Lee Steere, "Hawthornden", Toodyay, W.A.
J. G. McIntyre, "Beralli", Balranald, N.S.W.
E. P. S. Roberts, "Minnel", Toobeah, Qld.
T. M. Scott, "Burroway", Narromine, N.S.W.
W. Weatherley, "Woolongoon", Mortlake, Vic.
R. C. Webb, "Habbies Howe", Seymour, Vic.

A procedure has been established for the care and handling of animals placed on loan to the Organization by the Trust, and also for the application of funds held by the Organization on behalf of the Trust for specific purposes in research projects.

Phytotron

Designs have reached an advanced stage for the building and the controlled environment cabinets comprising the Canberra phytotron project. Details have now been decided for the necessary engineering services. The architects' plans and specifications for the building are complete, and tenders will be called early next financial year.

The prototype glass-house has been used for engineering tests of heat transfer and for the study of air movement patterns within and between cabinets. The reliability of the open-bench heat-pump units has been demonstrated, and the control achieved by this type of unit on glass-house temperature has proved closer than expected.

Engineering and biological tests of various types of naturally lit cabinets have continued, and artificially lit units are also being developed.

New Fisheries Research Vessel

A new vessel to assist in research for the barracouta fishing industry—the F.R.V. *Thyrsites*—was completed and launched in Melbourne in November 1959. The vessel is 42 ft in length, of all-steel construction, has diesel engines, and is equipped with echo-sounding devices. It was built by the Acro Steel Works, Melbourne, and its construction was financed with the cooperation of the Commonwealth Department of Primary Industry from the Fisheries Development Trust Fund. The Department of Primary Industry is also contributing £3500 per year from the Fund for 5 years towards the running costs of the vessel.

The *Thyrsites* will make eight cruises a year in Bass Strait, and will enable officers of the Division of Fisheries and Oceanography to study the feeding, spawning, and migratory habits of the barracouta.

Collaboration with the Universities

As in the past, Divisions and Sections have continued to collaborate with the universities in special fields of study. A number of new arrangements have been made with universities; in addition to those referred to elsewhere in this report, these include:

Support to the Department of Zoology, University of Melbourne, to investigate the effects of chromosomal inversion on viability of grasshoppers. This work is related to genetic investigations in the Division of Plant Industry and the Division of Entomology.

Collaboration by the Division of Protein Chemistry with the University of New South Wales in establishing a research programme to investigate tritium labelling techniques.

Arrangements with the Australian National University for the continuation of research into aggregation and denaturation of protein. These investigations are associated with studies of casein being undertaken by the Dairy Research Section.

Transfer on extended loan of the differential analyser developed by the Mathematical Instruments Section to the Electrical Engineering Department, University of Tasmania.

Officers of C.S.I.R.O. have continued to assist in university teaching work by giving courses of lectures in specialized fields and on specific research problems.

The Organization has also continued through the Electrical Research Board to support university research in electrical engineering, and grants were approved for the Universities of Sydney, Melbourne, Queensland, Adelaide, and New England.

The Radio Research Board to which C.S.I.R.O. is a major contributor has made grants for research in radio science at the Universities of Sydney, Melbourne, Queensland, Adelaide, and New England.

Cooperative Industrial Research

There are various ways in which the Organization cooperates with industry in conducting research. These range from undertaking single sponsored research programmes to cooperation with autonomous industrial research associations. The Organization welcomes proposals for cooperative research from individual firms or industrial groups.

The Industrial Research Liaison Section has continued its activities in fostering the application of the results of C.S.I.R.O. research in the fields of secondary industry.

The Organization continued to provide financial support to the Bread Research Institute of Australia, the Wine Research Institute, and the Australian Coal Association (Research) Ltd. The Australian Leather Research Association, however, recently went into liquidation but alternative proposals for research in this field are at present receiving active consideration. A new laboratory for the Bread Research Institute of Australia was completed on land at North Ryde made available by the Organization. The laboratory adjoins the site of the buildings under construction for the Division of Food Preservation and Transport and it provides accommodation for the Wheat Research Unit of C.S.I.R.O. A central laboratory for the Australian Coal Association (Research) Ltd. is now nearing completion, also on land at the North Ryde site made available by the Organization in close proximity to the Laboratory of the Division of Coal Research.

A number of new cooperative research projects sponsored or otherwise assisted by industrial firms have been commenced during the year. These include an expanded programme on fibrous plaster and plaster of paris by the Division of Building Research, with support from the Colonial Sugar Refining Co. Ltd., Australian Plaster Industries Pty. Ltd., and Associated Fibrous Plaster Manufacturers of Australia; research on bacterial fertilizers, in the Division of Soils, with support from Australian Fertilizers Ltd., Cuming Smith and Mt. Lyell Farmers Fertilizers Ltd., and Commonwealth Fertilizers Ltd.; a programme on flotation of beryl, in the Melbourne Ore-dressing Laboratory, supported by Northwest Tantalum N.L. and Consolidated Zinc Pty. Ltd.; work in the Division of Physical Chemistry, on the application of cetyl alcohol for reducing evaporation from water storages, with assistance from Prices (Bromborough) Ltd.; a study of the behaviour of a lightweight concrete flat plate structure under load, in the Division of Building Research, with support from several firms associated with the building industry and assistance from the Victorian Housing Commission; research on thorium production in the Division of Mineral Chemistry and on continuous ion-exchange processes in the Division of Physical Chemistry, both with assistance from Consolidated Zinc Pty. Ltd.; microbiological prospecting for oil deposits by the Division of Soils, in cooperation with the Department of National Development, and with assistance from members of the Australian Petroleum Exploration Association Ltd.

A full list of contributions and donations for research received by the Organization is given in Chapter 4.

Giant Radio Telescope

Construction of the giant radio telescope at Parkes, N.S.W., for the Division of Radiophysics is now well advanced. The reinforced concrete tower which will support the steel turret and aerial has already been erected on the site, and fabrication of the turret (which carries the elevation axis and driving motors, and itself rotates on a hardened steel track set in the top of the tower to provide rotation in azimuth) has now been completed in Germany by the contracting firm Maschinenfabrik Augsburg-Nurnberg A.G. The steel "mirror" is to be assembled on the site from Australian steel. It is expected that the whole project will be completed early in 1961.

The Rockefeller Foundation of New York has made a further donation of $107,000 towards the cost of the telescope, bringing the Foundation's total contribution towards this project to $357,000. The Commonwealth Government has also agreed to an additional grant of approximately £150,000 towards the cost of the telescope.

Overseas Visitors

During the year many leading scientists from overseas countries visited Australia either to discuss research problems or to work in the Organization's laboratories. The number of overseas visitors studying in collaboration with C.S.I.R.O. officers

continued to increase. These included visitors from: United Kingdom, Europe, U.S.A., Canada, Argentina, and Chile. In addition, Colombo Plan, U.N.E.S.C.O., and F.A.O. Fellows have undertaken collaborative investigations and received specialized training.

The Organization, through the Animal Research Laboratories, acted as host, on behalf of the Commonwealth Government, to the meeting of the Expert Panel on Contagious Bovine Pleuro-pneumonia established by F.A.O. Delegates to the meeting, which was held in Melbourne in April 1960, came from Portugese West Africa, French Equatorial Africa, Kenya, Nigeria, the United Kingdom, and the F.A.O. headquarters in Rome.

Amongst other overseas visitors received by C.S.I.R.O. during the year were:

Professor L. Biermann, Director of the Max Planck Institute for Astrophysics, Munich, Germany, whose visit to Australia was sponsored by the Organization and the Australian National University.

Professor H. Fröhlich, of the University of Liverpool, England, who was invited to Australia by the Organization to discuss research in dielectrics with officers of the Division of Electrotechnology.

Mr. J. R. Angus, Conservator for Forests, Fiji, who visited Australia to discuss problems in the exploitation of indigenous timbers of Fiji.

Dr. F. J. Simmonds, Director, Commonwealth Institute of Biological Control, Canada, who visited Australia under the auspices of the Commonwealth Agricultural Bureaux and C.S.I.R.O. to discuss problems connected with the biological control of plant and insect pests.

Dr. D. J. Finney, F.R.S., University of Aberdeen, Scotland, who was invited to Australia by C.S.I.R.O. to discuss theoretical and applied aspects of statistics, especially those affecting biological research.

Mr. Y. Satyanarayan, of the Central Arid Zone Institute, Jodhpur, who is spending some months with officers of the Division of Land Research and Regional Survey under the auspices of U.N.E.S.C.O.

Dr. B. P. Uvarov, C.M.G., F.R.S., formerly Director of the Anti-Locust Research Centre, London, who visited the Division of Entomology and State entomologists to discuss research into the control of locusts and grasshoppers.

Associate Professor R. R. Braham, University of Chicago, who came to Australia at the invitation of the Snowy Mountains Hydro-Electric Authority and the Organization to discuss aspects of the Cloud Physics Research programme of the Division of Radiophysics.

Professor H. A. Scheraga, Cornell University, New York, U.S.A., who attended the Summer School in Protein Chemistry held by the C.S.I.R.O. Division of Protein Chemistry.

Dr. E. G. Carter, of the International Wool Secretariat, and Dr. G. Laxer, of the Wool Bureau Incorporated, who visited Australia at the invitation of the Australian Wool Bureau to confer with officers in C.S.I.R.O. laboratories undertaking wool research.

Dr. E. H. Mercer, of the Chester Beatty Research Institute, London, who spent a period as a guest worker with the Division of Food Preservation and Transport collaborating on research into the fine structure of bacterial spores.

Dr. W. M. Hamilton, Secretary of the Department of Scientific and Industrial Research, New Zealand, who visited a number of C.S.I.R.O. laboratories during a brief stay in Australia.

Two Fulbright Fellows commenced research programmes in C.S.I.R.O. laboratories: Dr. E. S. Hodgson, Associate Professor of Zoology, Columbia University, U.S.A., who is studying the neurophysiology of insects at the Division of Entomology; and Dr. L. Bogorard of the University of Chicago, U.S.A., who is spending 6 months at the Division of Plant Industry studying plant biochemistry.

Overseas Visits

Officers of the Organization received invitations to participate in a number of overseas scientific conferences. These included the International Conference of the Institute of Food Technologists, San Francisco, U.S.A.; the International Seminar of Solar Water Relationships, Los Angles, U.S.A.; the Conference on the Coherence Properties of Electromagnetic Radiation, Rochester, U.S.A.; the Meeting of the British National Society of Soil Mechanics and Foundation Engineering, London, U.K.; the International Union of Pure and Applied Chemistry Symposium on Thermodynamics at Munich, Germany; the International Conference on Plant Growth Regulators, New York, U.S.A.; the U.N.E.S.C.O. Conference on Plant Water Relationships, Madrid, Spain; the Ninth International Botanic Conference, Montreal, Canada; the International Mineral Processing Congress, London, U.K.; the Third Gas Chromatography Symposium of the American Dairy Science Association, Atlantic City, U.S.A.; the Ninth New Zealand Science Congress, Wellington; Gordon Research Conference on Inorganic Chemistry, New Hampton, U.S.A.; and the 13th Annual Research Conference, Oak Ridge National Laboratory, U.S.A.

In addition a number of officers were included in a delegation of Australian scientists who attended the Second Quinquennial Wool Textile Conference held at Harrogate, England. The delegation was led by Dr. F. G. Lennox of the Division of Protein Chemistry.

Dr. F. W. G. White, Chairman of C.S.I.R.O., attended the Madrid Meeting of the World Power Conference and the Second Quinquennial Wool Textile Research Conference. Dr. White also visited national research organizations in Thailand, India, Pakistan, the United Kingdom, and Europe. Before returning to Australia he will attend the Royal Society Tercentenary Celebrations and will represent Australia at the British Commonwealth Scientific Committee Conference.

Mr. Guy B. Gresford, Secretary of C.S.I.R.O., attended the U.N.E.S.C.O. Regional Meeting of representatives of National Scientific Research Organizations held at Bandung, Indonesia.

Dr. I. W. Wark, Director of the Chemical Research Laboratories, attended the International Mineral Processing Congress in London to deliver the Sir Julius

Wernher Memorial Lecture. He also visited research establishments in the United Kingdom, Europe, and the U.S.S.R.

Dr. O. H. Frankel, Chief of the Division of Plant Industry, attended the Tenth Conference of F.A.O. as a member of the Australian delegation.

Mr. F. G. Nicholls visited Pakistan at the invitation of the Pakistan Government as a member of an International Committee to advise on the organization of scientific research. In June Mr. Nicholls went to Thailand, on an assignment for 12 months with the United Nations Technical Assistance Board, Bangkok, as adviser to the government of Thailand on the application of scientific research.

A number of officers proceeded overseas to undertake assignments on behalf of agencies of the United Nations to study new scientific developments, to obtain information on special research techniques, and for advanced study at the invitation of overseas research organizations.

C.S.I.R.O. Post-Graduate Studentships

The Organization continued to award post-graduate studentships to graduates for training in research, both in Australia and overseas. During the year, as a result of an investigation by the Studentship Committee of the allowances payable to holders of studentships, increases were approved for awards held in Australia and in the U.S.A. Studentships now carry the following living allowances:

Junior Studentships	£600–800 p.a.
Senior Studentships	£900–1100 p.a.
Overseas Studentships	£750 sterling p.a. in U.K. and Europe $3000 p.a. in U.S.A.

Junior Post-Graduate Studentships

These are awarded for one year only, to persons holding a pass degree in Science, Agricultural Science, Veterinary Science, Engineering, or Arts with Mathematics as the main subject. During the year, 23 of these studentships were awarded (four were subsequently declined), successful candidates (and their universities) being:

G. A. Chilvers (Sydney)
H. A. Cohen (Sydney)
L. R. Davidson (Western Australia)
B. R. Davis (Adelaide)
C. McD. Francis (Western Australia)
B. E. Johnstone (Melbourne)
A. S. Jones (Adelaide)
D. F. Kerr (Queensland)
P. M. Martin (Sydney)
K. R. Matthews (Queensland)
Miss B. M. Ogilvie (New England)
E. M. Palandri (Western Australia)
L. A. Parcell (Queensland)
I. D. Rae (Melbourne)
G. C. Ramsay (Adelaide)
J. S. Reid (Tasmania)
D. C. Rogers (Melbourne)
B. M. Seppelt (Adelaide)
P. Szekeres (Adelaide)
B. K. Taylor (Adelaide)
R. F. Tuddenham (New South Wales)
H. Weigold (Adelaide)
M. Whitley (Sydney)

Senior Post-Graduate Studentships

These are awarded for two years initially to persons holding at least an Honours degree in the fields listed. The period of the studentship may be extended for an additional year under special circumstances. During the year nine awards were made, five of them being declined subsequently. Successful candidates were:

O. R. Byrne (Adelaide)
D. H. Collins (Western Australia)
J. M. Eckert (Sydney)
J. E. A. Gooden (Adelaide)
Miss J. W. Hedger (Adelaide)
G. A. R. Johnston (Sydney)
J. M. W. McKenzie (Otago)
R. G. Storer (Adelaide)
G. S. Wells (Adelaide)

Overseas Studentships

These are awarded to research workers in science and allied fields who have obtained a Ph.D., or who are about to obtain that degree, to enable them to proceed overseas usually for one year only, to work with leaders of research in their special field of interest. During the year, 11 Overseas Studentships were awarded, successful applicants being:

T. C. Chambers (Sydney)
Dr. C. H. Doy (Melbourne)
B. M. Johnstone (Melbourne)
R. T. Lange (Western Australia)
I. McDougall, (Australian National University)
K. S. McWhirter (Sydney and Wisconsin)
K. C. Marshall (Sydney and Cornell)
A. C. Moritz (Adelaide)
G. Playford (Western Australia and Cambridge)
Dr. N. W. Tschoegl (New South Wales)
J. A. L. Watson (Western Australia and Cambridge)

In addition, three C.S.I.R.O. officers have been awarded Divisional Overseas Studentships.

Studentships Awarded by Outside Bodies

The Organization was asked to select candidates for Australian Dairy Produce Board Post-Graduate Studentships at the request of the Board, and chose four persons for Junior Studentships, two for Senior Studentships, and four for Overseas Studentships, from the applicants for these awards.

Similarly, at the request of the Wool Research Committee, three persons were selected as being eligible for Wool Research Fellowships.

Science And Industry Endowment Fund

The Executive, as Trustees of the Science and Industry Endowment Fund, made grants to assist the following research workers: Dr. Monica M. Cole, to undertake a survey of the savannah areas of Queensland and the Northern Territory to assess the land potential of these areas; Dr. T. O. Browning, to study the ecology of the tick (*Ornithodoros gurneyi*); Mr. A. W. Parrott, to continue a taxonomic study of Australian parasitic wasps; Mr. N. V. Dobrotworsky, to

continue studies of the systematics and ecology of the Victorian mosquitoes; Dr. R. T. Patton, to study distribution and environmental factors of Victorian plant communities; Mr. J. P. Kelsall, to complete studies of tamar (*Protemnoclon eugenii*) populations of the Abrolhos Islands and Garden Island, W.A.; Dr. J. Pearson, to continue investigations on the anatomy and embryology of Australian marsupials; Mr. W. P. Butler, to undertake investigations on speciation problems in brown snakes (*Demansia nuchalis* and *D. affinis*); Dr. Mary E. Gillham, to complete a study of the ecology of mutton bird nesting areas in Australia; Dr. J. A. Keast, to continue studies of species formation in vertebrates; Mr. P. H. Colman and Mr. R. Burn, to study the taxonomy of Australian marine Mollusca.

Grants were made towards travelling expenses of the following research workers:

Dr. C. J. Magee, to attend the Sixth Commonwealth Mycological Conference and the Commonwealth Agricultural Bureau Review Conference in London; Dr. J. W. Evans and Dr. K. Immelmann, to study the behaviour of the Australian finches (Ploceidae); Dr. C. R. Guiler to attend a special meeting of the Royal Society of London to discuss the biology of the southern temperate region; Mrs. P. M. Thomas, in connexion with the biological B.A.N.Z.A.R.E. reports.

A grant was made to the Royal Society of Victoria to assist Professor Ernst Mayr of Harvard University to attend the Society's centenary celebrations. Professor Mayr delivered the Tiegs Memorial Oration and took part in the Society's symposium, "The Evolution of Living Organisms", to commemorate the centenary of the publication of Darwin's *Origin of Species*.

Grants were made to students of the Universities of Queensland, Adelaide, Western Australia, and Tasmania, to enable them to attend the School of Marine Biology held at the Division of Fisheries and Oceanography, Cronulla, N.S.W.

Buildings and Accommodation

During the year the following buildings were completed:

Australian Capital Territory:

Canberra	Glasshouse insectary, Division of Entomology
Ginninderra	Overseer's residence, Division of Plant Industry

New South Wales:

Griffith	Workshop, Irrigation Research Station
North Ryde	Shower and change room, and inflammable materials' store, Division of Coal Research

South Australia:

Adelaide	Workshop and store, Division of Soils

Victoria:

Melbourne	Amenities block, Division of Animal Health
	Building extension, Chemical Engineering Section

The following are the more important buildings in course of construction:

Australian Capital Territory:

Canberra	Biochemistry laboratory and new genetics laboratory wing, Division of Plant Industry
Ginninderra	Manager's residence and implement shed, Division of Plant Industry

New South Wales:

Armidale	Additions to Rural Science Building, Division of Animal Physiology
Griffith	Extension to main building, Irrigation Research Station
Prospect	Caretaker's cottage, feed store, and radioisotope laboratory, Division of Animal Physiology
North Ryde	New laboratory and associated buildings, Division of Food Preservation and Transport
Ryde	High pressure laboratory, Division of Physical Chemistry

South Australia:

Adelaide	Laboratory No. 2, Division of Soils

Finance

Details of the expenditure of £9,489,741 incurred during 1959–60 are set out in Chapter 4. Of this sum £8,862,160, was expended on normal research activities, £482,981 on capital works, and £144,600 on grants to outside bodies. Funds for this expenditure were derived from the Commonwealth Treasury, contributions from other sources including the Wool Research Trust Fund Trust Account, and revenue from miscellaneous sources.

The following table summarizes the sources of these funds, and activities on which they were expended.

SOURCE OF FUNDS	Investigations	Capital Works	Grants to Outside Bodies	TOTAL
	£	£	£	£
Treasury Appropriation	7,070,203	170,324	144,600	7,385,127
C.S.I.R.O. Revenue	96,676			96,676
Total Treasury Funds	7,166,879	170,324	144,600	7,481,803
Wool Research Trust Fund Trust Account	1,273,575	209,801		1,483,376
Contributions (other than Wool)	421,706	102,856		524,562
	8,862,160	482,981	144,600	**9,489,741**

The Organization is particularly gratified by the way many organizations continue their support, and by the marked interest shown by certain sections of industry which provided funds for cooperative research. Among the many

contributions received, reference should be made to those of the Australian Meat Board, the Australian Dairy Produce Board, the Australian Egg Board, the Queensland Meat Industry Board, the New South Wales Department of Agriculture, the New South Wales Water Conservation and Irrigation Commission, the Metropolitan Meat Industry Board of New South Wales, the Ian McMaster Bequest, the Alexander Fraser Memorial Fund, the Burdekin Bequest, the dried fruits industry, the Australasian Institute of Mining and Metallurgy, the State Electricity Commission of Victoria, the Cement and Concrete Association of Australia, the timber industry, the plaster industry, the Paint Manufacturers' Association, the paper industry, the United Graziers' Association of Queensland, Broken Hill Associated Smelters Pty. Ltd., the River Murray Commission, the Snowy Mountains Hydro-Electric Authority, the Department of Health, Education, and Welfare (U.S.A.), Smith, Kline, and French Laboratories, U.S.A., Western Australian Chamber of Mines (Inc.), and the Population Council (Inc.), U.S.A. In addition, a number of Commonwealth Government Departments provided funds for specific research projects on their behalf.

Organization

For carrying out its research work, C.S.I.R.O. has established several major Laboratories, and a number of Divisions and Sections. The four major Laboratories are the National Standards Laboratory grouping three Divisions, the Chemical Research Laboratories grouping three Divisions and three Sections, the Wool Research Laboratories grouping three Divisions, and the Animal Research Laboratories grouping three Divisions. There are also 15 independent Divisions in other research fields and an additional 15 independent Sections comprising establishments which have not reached a state of development so far as the scope and magnitude of their operations are concerned to justify their designation as Divisions.

Since the investigations extend on a Commonwealth-wide basis and many investigations—particularly those concerned with the agricultural and pastoral industries—necessitate experimental work in the field, a number of branch laboratories and field stations have been established in various parts of Australia.

The Head Office is in Melbourne and associated with it are the central Library, Agricultural Research Liaison Section, Industrial Research Liaison Section, Editorial and Publications Section, Film Unit, and Publishing and Translation groups. The Organization also maintains Australian Scientific Liaison Offices in London and Washington.

MAJOR LABORATORIES

National Standards Laboratory, consisting of the following Divisions:

Metrology, Sydney;
Physics, Sydney;
Electrotechnology, Sydney.

Chemical Research Laboratories, consisting of the following Divisions:

Chemical Physics, Melbourne;
Mineral Chemistry, Melbourne;
Physical Chemistry, Melbourne;

and the following Sections:

Cement and Refractories, Melbourne;
Chemical Engineering, Melbourne;
Organic Chemistry, Melbourne.

The Laboratories have their headquarters in Melbourne and a branch laboratory in Sydney.

Wool Research Laboratories, consisting of the following Divisions:

Protein Chemistry, Melbourne;
Textile Physics, Ryde, N.S.W.;
Textile Industry, Geelong, Vic.

Animal Research Laboratories, consisting of the following Divisions:

Animal Genetics, with headquarters in Sydney, laboratories in Sydney and Rockhampton, Qld., and field stations at Badgery's Creek, N.S.W., at Rockhampton and Cunnamulla, Qld., and at Werribee, Vic.

Animal Health, with headquarters in Melbourne, laboratories in Sydney and Brisbane, and field stations at Tooradin and Werribee, Vic., and at Amberley, Qld.

Animal Physiology, with headquarters at Prospect, N.S.W., and laboratory and field station at Armidale, N.S.W.

INDEPENDENT DIVISIONS

Plant Industry, with headquarters in Canberra and main laboratories in Canberra, regional laboratories in Perth, Hobart, and Deniliquin, N.S.W., and field stations, experimental farms, etc. at Applethorpe and Mareeba, Qld., at Kojonup, W.A., and at Canberra.

Entomology, with headquarters and main laboratories in Canberra, a smaller laboratory in Sydney, and field stations at Trangie, N.S.W., at Rockhampton, Qld., and at Perth.

Biochemistry and General Nutrition, with headquarters in Adelaide and field stations at O'Halloran Hill, Robe, and Brecon, S.Aust.

Soils, with headquarters and laboratories in Adelaide, and branch laboratories in Perth, Canberra, Brisbane, Melbourne, and Hobart.

Forest Products, Melbourne.

Food Preservation and Transport, with headquarters and laboratories in Sydney, branch laboratories in Brisbane and Hobart, and a minor laboratory in Gosford, N.S.W.

Fisheries and Oceanography, with headquarters and main laboratories in Cronulla, N.S.W., laboratories in Perth and Melbourne, and field stations at Hobart and Thursday Island.

Radiophysics, Sydney.
Tribophysics, Melbourne.
Building Research, Melbourne.
Mathematical Statistics, Adelaide.
Meteorological Physics, Melbourne.

Land Research and Regional Survey, with headquarters in Canberra, and field stations at Alice Springs, Katherine, and Darwin, N.T., and in the Kimberley region, W.A.

Tropical Pastures, with headquarters in Brisbane, a laboratory at Lawes, Qld., and field station at Samford, Qld.

Coal Research, Sydney.

INDEPENDENT SECTIONS

Irrigation Research Stations, at Merbein, Vic. (Murray Irrigation Areas) and Griffith, N.S.W. (Murrumbidgee Irrigation Areas).
Fodder Conservation, Melbourne.
Ore-dressing Investigations, Melbourne and Kalgoorlie, W.A.
Mineragraphic Investigations, Melbourne.
Dairy Research, Melbourne.
Physical Metallurgy, Melbourne.

Wildlife Survey, with headquarters in Canberra and field stations at Perth, and Albury, N.S.W.

Agricultural Research Liaison, Melbourne.
Industrial Research Liaison, Melbourne.
Soil Mechanics, Melbourne.
Upper Atmosphere, Camden, N.S.W.
Wheat Research Unit, Sydney.
Editorial and Publications, Melbourne.
Engineering, Melbourne.

REGIONAL CENTRES

These are cooperative research units staffed with officers from the appropriate specialist Divisions to attack the problems of a particular region.

Tasmanian Regional Laboratory, Hobart.
Western Australian Regional Laboratory, Perth.

2

Progress in Research

This chapter consists of a brief survey of some of the more important and interesting developments arising during the year under review from the research being carried out in the Organization's laboratories and field stations. It is not intended to be comprehensive. A complete account of the progress of the research programmes for the year will be published separately as a Research Review.

In this chapter technical terms have been reduced to a minimum since it is not a technical report or a scientific record for use by specialists. Details of scientific references may be found for many of the individual projects in the list of scientific papers that have been published and of letters patent that have been granted during the year under review; this list appears in Chapter 3.

Gypsum and Riverina Pastures

Serious problems preventing the development by irrigation of large areas of potentially fertile but intractable soils in the Riverina have been solved by the application of gypsum. By using low concentrations of gypsum in the irrigation water to make the surface clays permeable, the cost of treatment has been greatly reduced.

Much of the 1,800,000 acre-feet of water per annum to come from the Snowy Mountains scheme within the next decade or so could be used to irrigate such soils. The use of gypsum in the manner developed at the Regional Pastoral Laboratory, Deniliquin, N.S.W., may also have applications on other soils elsewhere in Australia.

The research leading to the solution of the practical problem began through a basic study of the complex physical chemistry of sodium clays by an officer of the Division of Soils, working temporarily at the Rothamsted Experimental Station in England. Theories developed from this apparently unrelated study led through a series of laboratory experiments to successful field trials. Other research groups developed farm-scale machinery that makes possible the accurate addition of gypsum to the irrigation water in the small quantities required.—*Divisions of Plant Industry and Soils, and the Engineering and Chemical Engineering Sections.*

Cattle for the Tropics

The importance of coat type for cattle in the tropics has been appreciated by scientists for a long time. Nevertheless, few would have guessed how accurately a beast's coat shows its ability to thrive, produce, and reproduce in a hot environment.

The new knowledge has come from a study of coat characters at the "Belmont" station, near Rockhampton. The work showed that the shorter and sleeker the coat, the faster the animal grows. So important is coat type for cattle in the tropical environment at "Belmont" that future weight gains can be predicted much more accurately from an animal's coat type than from actual records of its past weight gain. Cows with sleek coats dropped more calves, and heavier calves, than those with woolly coats. Fortunately, coat type is strongly inherited.

These findings are known to be applicable elsewhere in a wide variety of environments, from New Guinea to Victoria.—*Division of Animal Genetics.*

Fruit Fly Research

Wasps which parasitize the Queensland fruit fly have been introduced from Hawaii and at least one species has been established successfully in the field in both north Queensland and northern New South Wales. Other wasps have been released in Western Australia, where the Mediterranean fruit fly is active. Approximately half a million parasites have been brought to Australia over the past two years.

The most promising of these Hawaiian wasps lays its eggs in the fly maggots, which are killed when the larvae of the parasite hatch out.

Studies of the Queensland fruit fly in commercial orchards are leading to a better understanding of its behaviour and reaction to local conditions. Particular attention is being paid to the factors that may limit its further spread in the southern States.—*Division of Entomology.*

Efficiency of Wool Growth

Among sheep of the same breeding, large differences in wool-growing capacity due to differences in the efficiency of conversion of feed into wool have been observed. The differences, if expressed in general terms, imply that the best producers in a flock may grow wool at two to three times the rate of the lowest producers when given the same amount of feed. On this basis, if a flock was improved so that it consisted of individuals as efficient as the top half of the original flock, average fleece weight would be raised by about a pound per head. Evidence has been adduced suggesting that the efficiency of an individual sheep can be gauged by relating its rate of wool growth to its body weight, because feed intake at pasture seems to be proportional to body weight. Long-term experiments have, therefore, been begun to measure the heritability of efficiency in Merino sheep, and to devise methods of measuring feed intake and digestibility in grazing sheep.—*Division of Animal Physiology.*

Whale Watching

On September 3 and 23, 1959, two marked whales were recovered off Carnarvon, W.A. The marks had been fired into these whales near Moreton Island, Qld. on July 23, 1954 and July 26, 1955. This discovery implies that the stocks of humpback whales in the waters off Australia's east and west coasts cannot be considered as entirely independent. The whaling industry may need to reappraise its outlook in the light of this important finding.—*Division of Fisheries and Oceanography.*

Rindless Cheese

A new process by which cheese is matured in a plastic wrapping has been successfully adapted for Australian conditions. The curd is first processed in a removable bandage and then matured inside a moisture- and oxygen-proof plastic film. The method prevents both the formation of wasteful rind and the growth of unsightly moulds. Experimental batches of the new plastic-covered rindless cheese were very successful, and commercial shipments have since earned a high reputation. It is expected that the new product will comprise about one-fifth of all Australian cheese exported during the next 12 months.—*Dairy Research Section.*

How Plants Resist Disease

A new kind of anti-fungal compound has been isolated from peas. It was identified during the course of research aimed at discovering why some plants resist disease while others are susceptible.

The new compound has been named "Pisatin" and is the first of the substances known as phytoalexins to be isolated and characterized. Although it occurs only in small amounts, sufficient of the substance to enable its structure to be determined was obtained by processing the produce from an acre of peas.

Further investigation suggests that each plant produces a characteristic but chemically different phytoalexin in response to infection. However, in any one plant the same phytoalexin is produced regardless of the nature of the fungal attack.—*Division of Plant Industry.*

Conserving Fodder

Farmers often leave hay bales out in the paddock for several months as a short-term fodder reserve, thereby taking the risk that weather damage will be counterbalanced by savings in carting and stooking. Although this risk may be justified with round bales, rectangular bales should normally be stooked.

New techniques that speed up curing and reduce losses are being tested, as well as "short-cut" methods that enable more hay to be handled. Basic studies are allowing a better understanding of haymaking and ensilage which will aid the development of improved field practices.—*Fodder Conservation Section.*

Irrigation in the Remote North-West

The Kimberley Research Station on the Ord River in Western Australia was established in 1945 as a joint enterprise with the Government of that State. Research work over the past 15 years has provided information on ways and means of producing a variety of crops under irrigation in this hot monsoonal environment.

Studies with rice and the oil crop, safflower, have proved so successful that the Western Australian Government has now decided to establish an irrigation area of some 15,000 acres. The site of the scheme is in the Ord River valley; land clearing has already begun. It is expected that large-scale commercial production will have commenced by 1963.

Rice yields compare favourably with those of other tropical countries. Safflower is particularly successful, and yields of up to 2500 lb per acre have been obtained. The residue, after extraction of the oil from the seed, is an excellent protein supplement for livestock.—*Division of Land Research and Regional Survey.*

More Productive Winter Pastures

Although improved pastures based on *Phalaris tuberosa* provide striking increases in production on the tablelands of southern Australia, their ultimate carrying capacity is limited by winter growth. One way in which attempts are being made to overcome this production bottleneck is to develop alternative pastures which make appreciable growth during the colder months.

A strain of cocksfoot grass introduced many years ago from Brignolles in France has proved outstandingly productive as a component of such so-called seasonal pastures in experiments near Canberra. During each of the past two winters, sheep grazing Brignolles cocksfoot have produced 1 lb of wool per head more over the winter than similar sheep grazing adjacent phalaris pastures.

Not only has this cocksfoot shown a greater capacity to grow at low temperatures, but it has persisted well under heavy stocking. Another strain of the same species, known as Neptune, is proving valuable in the dairying pastures of Western Australia.—*Division of Plant Industry.*

Rabbit Control by Poisoning

The dramatic success of myxomatosis in reducing rabbit numbers over much of eastern Australia temporarily diverted public attention from other methods of control. However, the use of poisoned baits incorporating compound "1080" provides a technique that can give percentage kills not far below those achieved by myxomatosis at its virulent peak.

"1080", or sodium fluoracetate, was originally developed as a rat poison in the U.S.A. and, because of its effectiveness and low cost, it has already become the foremost rabbit poison in Australia. It is not a selective poison, but is not dangerous provided simple obvious precautions are taken. Recent research indicates that the concentration in baits can be reduced to 0·02 per cent., or probably even less.

Trials have shown that carrot bait is acceptable at all times of the year but that it loses its toxicity when exposed to alternate sunshine and rain. Oat bait, on the other hand, although remaining toxic for a much longer period, is not so readily eaten by rabbits during summer heat. Furthermore, oats are an unsuitable bait to use during the breeding season, when young rabbits with milk teeth cannot cope with such harsh feed.

"1080" poisoning using a suitable bait can give kills of over 90 per cent., but its effective use depends on intelligent application of knowledge gained through research into the feeding habits and behaviour of the rabbit.—*Wildlife Survey Section.*

Big Gains in Beef Production

The tremendous productive potential of some tens of millions of acres of well-watered but comparatively undeveloped land in eastern Queensland below the Tropic is strikingly illustrated by the most recent figures from a large grazing trial. This experiment on native spear grass country near Gladstone has now been in progress for several years.

Improved pastures based on cultivation and sowing of a grass-legume mixture turned off beef at the rate of 153 lb liveweight per acre. Unfertilized native pasture showed a net production for the year of only 15 lb liveweight per acre, while native pasture oversown with Townsville lucerne and topdressed with superphosphate and potash produced at the rate of 110 lb per acre.

The improved pastures not only carried more stock, but brought the stock to killing weights one year earlier than did the unimproved native pasture. The topdressing and oversowing of native pasture with Townsville lucerne should be profitable under commercial conditions.

The establishment of similar high-producing pastures in other parts of the subtropics depends on success in finding suitable pasture legumes. A world-wide search for these key plants has met with some success, and several potentially valuable species are now being adapted for local conditions.—*Division of Tropical Pastures.*

Progress in Studies on Lamb Losses

Further evidence obtained during the investigations over the last year confirms the primary importance of nutritional factors in determining the mortality among new-born lambs. Pregnant ewes that are inadequately fed, especially during the third term, tended to drop weak, underweight lambs. The mothering instinct of such ewes also tended to be low, the onset of their lactation delayed, and the quantity of their milk restricted. When these conditions prevailed, severe weather at lambing time precipitated high mortality. Evidence from other studies indicates that undernutrition of ewes during late pregnancy is widespread throughout Australia and is often the cause of loss, not only of the lambs, but also of the ewes owing to pregnancy toxaemia. Improved methods have been developed for assessing the nutritive requirements of pregnant ewes, because the traditional

methods of eye appraisal are so liable to error. Thus, it has been observed that a pregnant ewe in apparently good condition may nevertheless be in a critical state of undernourishment.—*Division of Animal Physiology.*

Chlorine Deficiency

Following the very recent discovery that the element chlorine is essential for growth and development of crop and pasture plants, a C.S.I.R.O. officer working at the University of California found acute symptoms of chlorine deficiency in subterranean clover which he grew in pots of soil collected in the foothills of the Sierra Nevada range.

Subsequently, pot tests of samples from selected locations in Western Australia revealed five soils which did not contain sufficient chlorine to grow subterranean clover to the flowering stage. This finding is somewhat unexpected, as saline soils of high chlorine content are very common in that State.—*Division of Plant Industry.*

A Step Nearer to Understanding Tick-Borne Fevers of Cattle

The cattle tick, itself a serious parasite, is responsible for spreading other parasites—the protozoon organisms which cause the so-called tick fevers in cattle. Although these parasites—*Babesia bigemina* and *B. argentina* –have long been identified, it was only during the last year that certain details of the life-cycle of *B. bigemina* in the tick and in the bovine have been revealed. These findings will form the basis for future progress in the study of the tick-borne diseases, which cause great economic loss. The life-cycle of the cattle tick itself has been fully understood only comparatively recently. Epidemiological work, based on the newly applied thick-smear technique for examining blood, has revealed that about 30 per cent. of the dairy cattle in some herds in northern Australia are infected with the protozoon organisms. *B. bigemina* was found to be the more prevalent in the younger animals, whereas *B. argentina* occurred more frequently in animals over 18 months.—*Division of Animal Health.*

Origin of Shallow Ground-Water

Large areas in the Upper South-East of South Australia are underlain by shallow ground-water. Pastoral settlement of the region has expanded rapidly and is dependent for its water on this underground supply. In view of its importance, an investigation was made to discover the source of the water and the effect that further settlement would have on the supply.

New methods of soil-water measurement were used. It was shown that the natural uncleared mallee heath and improved sown pasture both utilized all the water entering the soil as rain. The origin of the ground-water is therefore not the local rainfall. The study indicated that the real sources are intake areas about 25 miles to the east, from which the water moves underground at a very

slow rate. Further development in this region may be limited by the speed with which water removed via bores and wells can be replaced by this slow movement from the east.—*Division of Soils.*

Progress in Flavour Chemistry

In flavour chemistry, a field of fundamental importance to dairy scientists, considerable headway has been made. The compounds causing such off-flavours as "cardboard", "oily", "tallowy", "painty", and "fishy" in butter have now been identified—a particularly tedious task because of the minute traces present. Most of the conditions under which these off-flavours develop have also been recognized. With this basic understanding a solution to the problem of how to place consistently high-quality butter on the London market may be nearer. Somewhat similar work has begun on identifying the pleasant or attractive flavours of butter, in the hope that it may prove possible to enhance them.—*Dairy Research Section.*

Better Pasture Plants

A strain of lucerne from abroad known as Hairy Peruvian is showing outstanding promise for winter production. It has yielded twice as much herbage as the standard commercial lucerne strain over the colder months at Deniliquin, N.S.W., and Canberra. The results have been confirmed over several years and seed is now being increased for farm-scale trial in other regions. The widespread use of such a winter-growing lucerne could do much to lift production in many parts of southern Australia where winter feed is an important factor limiting increased rates of stocking.

Other promising pasture plants introduced from overseas by the Organization are now coming into commercial use. Buffel grass strains from East Africa are now widely sown in Queensland, while a strain of *Bromus inermis* from the United States has been released commercially in New South Wales. Seed of high-yielding strains of vetch has been raised in Western Australia for large-scale distribution, and promising new clovers collected in the Mediterranean are under farm-scale trial in that State. Better varieties of tall fescue grass, introduced several years ago, have recently been distributed for farm trials on the Northern Tablelands of New South Wales and elsewhere.—*Division of Plant Industry.*

Water Resources of the Inland

Surveys in Western and central Australia have revealed underground water resources which are suitable for exploitation.

In an area north of Alice Springs, a study made in association with the Bureau of Mineral Resources has shown that the annual recharge of underground basins is 70,000 acre-feet. The total capacity of these aquifers is at least 50 times this amount, and the water is suitable for irrigation. Another interesting feature is that some of the water has a high nitrate content. If used for irrigation, the

application of every acre-foot would add the equivalent of 4 hundredweight of sulphate of ammonia.

Similar work in Western Australia has shown that one aquifer east of Lorna Glen has an annual flow of 350 acre-feet, and that the recharge rate could be doubled by using low dams to impound flood waters. Another aquifer, east of Wiluna, has a recharge rate sufficient for 280 acres of irrigated lucerne or 400 acres of cotton.—*Division of Land Research and Regional Survey.*

Darwin Rice Experiments

The Coastal Plains Research Station was established near Darwin last year, and the first experiments have now been conducted.

The rice industry in northern Australia, still in its embryo stage, faces a considerable array of problems. At the Station, research has been initiated on the fertilizer requirements of the crop, and on the selection of varieties of rice best suited to the environment. New techniques of planting are also under study. A method that consists of preparing land and dropping pregerminated seed on soil covered with water is showing considerable promise. Adaptations have been made to Australian machinery for this purpose.—*Division of Land Research and Regional Survey.*

Tracking the Cause of "Doggy Wool"

"Dogginess" in wool has been a problem for a very long time. However, some interesting facts have recently been uncovered which may eventually lead to a full understanding of this curious wool fault. Microscopic examination of the skin has shown that in "doggy" sheep the wool follicle has enlargements, or cysts, around its base. Work is now in progress to find a means of distinguishing "doggy" wool from the "steely" wool due to copper deficiency, and to ascertain whether "dogginess" is an inherent defect or due to environment. The broadening of the crimp is interpreted by wool buyers as indicating coarseness in the fibre, and so "doggy" wool usually fetches much less than good style wool.—*Division of Animal Physiology.*

Sulphur Lack Limits Pasture Benefits

Improved pastures not only increase production of wool and meat, but also have important indirect effects in raising the fertility of the soil in which they are growing. Research on long-established subterranean clover paddocks at Crookwell, N.S.W., has shown the nature and importance of this lift in soil fertility.

An increase in organic matter is the first step in a kind of chain reaction which brings about further changes in these soils and leads ultimately to increased availability of certain essential plant nutrients, and to beneficial changes in the physical structure of the soil.

Research at Crookwell has shown that sulphur is an essential constituent of the soil organic matter. In fact, in that area lack of sulphur often limits the rate of build-up of soil fertility under improved pastures.

The results show that the 13·5 lb of sulphur present in each hundredweight of superphosphate has led to the formation of 1 ton of soil organic matter. Each ton of organic matter has in turn made available for plant growth 6½ lb potassium, 25½ lb calcium, and 5·2 lb of magnesium, in addition to the 85 lb of nitrogen in the organic matter itself.—*Division of Plant Industry.*

Automatic Cheese-Making—A Commercial Success

The Dairy Research Section's plans for fully mechanized Cheddar cheese manufacture have taken another important step forward with the installation and successful operation of the first commercial plant. The machine automatically mills, salts, and hoops the cheese curd. It has proved capable of handling up to about 8000 lb of curd per hr, which leaves an ample output margin above the requirements of even the largest cheese factories. In commercial practice, the new plant cuts manufacturing costs considerably and makes working conditions in the factory much more pleasant. It has brought Cheddar cheese-making into line with modern concepts of food processing and handling; the whole operation is continuous and at no stage is the cheese touched by hand. Part of the machinery comprises a novel, electronically controlled device for measuring the salt into the mixing drum in exact proportion to the amount of curd. It is expected that this device will find application in other industrial processes.—*Dairy Research Section.*

Fertility of Rams

In the ram, the testicle is maintained at a temperature about 9°F lower than body temperature, and fertility is impaired if the testicular temperature is allowed to rise. Recent experiments have shown that the intricately coiled spermatic artery and the adherent spermatic veins form a highly efficient heat-exchange mechanism. The cooling effects of the scrotal skin are thus rapidly conveyed to the deep tissue of the testis. This study of the temperature-regulating mechanisms and of seasonal changes in semen quality is providing a sound basis for practical measures to protect the fertility of rams.—*Division of Animal Physiology.*

The Euro (Hill Kangaroo) in Western Australia

In the north-west of Western Australia, native pastures have deteriorated and sheep numbers declined in recent years. At the same time, the euro population has increased since the provision of more stock waters. Research has therefore been carried out on the habits of the euro and methods of control.

The only practicable method of control is by poisoning the drinking waters. It was found that even during the hottest period of the year euros do not drink every day, although water may be conveniently available. This demonstrates the necessity of poisoning water points for much longer periods than was

formerly considered necessary. A minimum of 6 days is now recommended. Poisoning should be attempted only under hot, dry conditions, for it is only then that the whole euro population will be watering with any frequency.

Poisoning of water points for extended periods presents certain practical difficulties, since it is necessary to remove stock from the poisoned area for the duration of the campaign. The system of deferred grazing, as recommended by the Western Australian Department of Agriculture, would largely overcome these difficulties.—*Wildlife Survey Section.*

Better Control of Cattle Tick

More efficient and less expensive means of controlling cattle tick are in sight as a result of knowledge gained through research on the life-cycle of this pest, which costs the Australian cattle industry nearly £10 million each year.

Pasture spelling and strategic dipping are two new concepts that have already proved successful in practice in southern and central Queensland tick areas. Early results from a field experiment in north Queensland are promising, and suggest that control of the cattle tick in that region also can be greatly improved by the use of both methods.

The search is also continuing for better chemicals for dipping and spraying. A multiple-resistant race of ticks has been found on a Queensland property; this race survives dipping with DDT, BHC, and dieldrin. Fortunately, there is as yet no sign of developing resistance to the organic phsophorus compounds.—*Division of Entomology.*

Cobalt Pellet Improved

New, heavier, and denser cobalt pellets have been developed. Although the earlier less dense pellets were used with spectacular success as a temporary measure, a proportion was lost by regurgitation during rumination.

The new pellets have been given increased weight and density by incorporation of finely divided iron. This has greatly improved their retention in the fore-stomachs of ruminant animals.

Experience has shown that under particular conditions of grazing, the surfaces of the pellets may be rendered inactive by deposits of calcium phosphate, or by the formation of an impervious, adherent, lustrous glaze. An abrading device has been evolved to overcome this difficulty. Administration of a steel grinder (such as an engineer's grub screw) along with the pellet ensures a clean and active surface.—*Division of Biochemistry and General Nutrition.*

Studying the Oceans

During the year two Royal Australian Navy frigates, H.M.A. Ships *Diamantina* and *Gascoyne*, which had been equipped with laboratories, were engaged on oceanographical surveys of the eastern section of the Indian Ocean and of the Tasman and Coral Seas.

In preparation for the rapid determination of the salt content in the hundreds of sea-water samples taken during a cruise, a highly sensitive salinity meter was designed. This instrument allowed the determinations to be done in a fraction of the time taken by analytical methods, and with very much greater accuracy. Already it has been possible to show that the bottom water in the Coral Sea Basin and the Solomon Trench came from the East Australian Basin, and not, as previously thought, from the Central Pacific.

These cruises were the first extensive deep-sea surveys made by Australian scientists. Sea-water samples were taken from various depths at about 100 stations for chemical analyses for the measurement of basic production, chlorophyll, phytoplankton, and zooplankton. These measurements indicate the type of water, circulation of water masses, and the association between water types, organisms, and fish occurrences.—*Division of Fisheries and Oceanography.*

Fattening Cattle in Northern Australia

Ever since white settlement, dry-season weight losses have retarded the cattle industry in northern Australia. Experiments at the Katherine Research Station have shown that this annual cycle of wet-season again followed by dry-season loss is by no means inevitable.

An intensification of land utilization involving the production of sown pastures and the growth of fodder and grain crops enables the cycle of gain and loss to be converted to a process of continuous gain. In one experiment, local cattle gained an average of 240 lb per head in 4 months when fed a supplement of sorghum grain and peanut meal. Over the same period, similar cattle on native pasture lost weight at a rate exceeding 1 lb per day.

In a full year, cattle grazing a sown pasture of Townsville lucerne and Birdwood grass during the dry season each gained an average of over 130 lb more than those in a group grazing only native pasture.—*Division of Land Research and Regional Survey.*

International Approval

The Organization's "complement-fixation" (C.F.) test has been accepted as the world's standard method for diagnosing contagious pleuropneumonia in cattle. Control or eradication of this disease is often particularly difficult because of the frequency of chronic and subacute or symptomless cases. Until the C.F. test was developed into a thoroughly reliable diagnostic aid, nowhere in the world was there a way of controlling pleuropneumonia except by the highly costly stratagem of slaughtering all recognizably affected beasts and all "in-contact" animals. Now, only those animals whose sera react positively to the C.F. test need be slaughtered. In accepting the C.F. test, the panel of experts appointed by the F.A.O. of the United Nations praised C.S.I.R.O. for its work on all aspects of pleuropneumonia and expressed appreciation of the help given to other nations in establishing the test in practice.—*Division of Animal Health.*

Sheep Selection

The dramatic increases in wool cut per head made possible by methods of sheep selection developed by C.S.I.R.O. are now well known. Further work has shown that these increases can be obtained without affecting the wool fibre. Indeed, sheep can be bred to have a wide variety of crimp length and diameter combinations.

The sheep that produce the most wool do so partly because they are the most efficient converters of food. They also eat more.—*Division of Animal Genetics.*

Exploration of New Breeding Methods

A completely new approach to animal breeding has recently been attempted. The first hint that it might be successful came from work, on laboratory animals, which suggested that the expression of inherited characters is much more complicated than had previously been assumed. It seemed as though variation in some characters was being prevented by other, apparently unconnected, genetic systems.

Research workers then found that this prevention of variation could be removed by temporarily introducing new genetic material. By this means they bred strains of mice and vinegar flies that showed variation in characters hitherto "invariable". The breeding experiments were based on mathematical analyses of theoretically possible explanations, carried out on an electronic computer. The experiments have picked out those theoretical possibilities which appear to hold in practice.

It has always been assumed that the strong tendency for hens to lay only one egg a day, and to lay only during daylight hours, is an "invariable" character of the kind worked on in laboratory animals. Geneticists are now trying to modify this character, this time not by genetic means but by changing the birds' environment. Already they have succeeded in breaking the normal egg-laying rhythm by keeping a flock in continuous light and noise. The birds now lay at any time of the day or night.

Having eliminated the day-to-day periodicity, the geneticists are now looking at the previously hidden underlying variation in time between successive eggs in a clutch. By selecting birds that lay the most eggs under these artificial conditions, they are hoping to be able to evolve even better poultry than those that they have already bred by conventional scientific methods and recently released to the industry.—*Division of Animal Genetics.*

Study of Australian Wild Ducks

There is an increasing interest in wild ducks as agricultural pests, reservoirs of disease, and game birds, but their conservation or control has been hindered by a lack of basic information on their habits.

Investigations extending over several years have shown that in the arid interior the ducks only breed when the dry creek beds and lagoons have been

filled by a recent rain or when there is a sharp rise in the water level of running streams. Breeding commences when and where suitable conditions develop, and, since rain in the inland is sporadic and non-seasonal, it may be initiated at any time of the year.

The grey teal breeds in response to a rise in water level even if rain has not fallen locally. The rising water level also causes an increase in the insect population, thus ensuring adequate food for the ducklings. The pink-eared duck, however, commences to breed only when low-lying land adjacent to the watercourses becomes flooded. Pink-eared ducklings consume large quantities of plankton, which is very prevalent in drying floodwaters. In this species also the breeding season is thus well timed to utilize available food supplies.

Studies of the feeding habits of the adult birds involved the examination of over 3800 gizzards. The various species eat much the same materials, but in varying proportions. The wood duck, for example, is almost totally dependent on vegetable food and eats large quantities of grasses, legumes, and sedges. The white-eyed duck derives about 20 per cent. of its diet from material of animal (mainly insect) origin, while the pink-eared duck lives almost entirely on animal food.—*Wildlife Survey Section.*

Growth of Detached Insect Tissue

Tissues have been kept alive and growing for long periods after removal from living insects. This is a big step towards the continuous growth of insect tissues, already achieved for plants and higher animals. The new technique should prove extremely useful and should have important applications in the solution of a wide range of insect problems. Some of the experimental tissue cultures lived longer than the insects from which they had been removed.—*Division of Entomology.*

Measuring Temperature in a Biscuit Oven

Biscuits are baked in long conveyor-type ovens, through which they are carried on an endless band. It is not practicable during baking to measure the temperature of the biscuits on the band by normal methods, as access to the oven interior is very limited. Equipment has been designed which overcomes these difficulties.

A temperature-sensitive device is connected to a miniature radio transmitter which travels through the oven on the band with the biscuits. A copper wire aerial inside the oven picks up the signal from the transmitter and takes it to a receiver outside the oven, where it is converted to a temperature reading on a meter or recorder.

The transmitter is insulated to withstand temperatures as high as 300°C for up to 20 minutes. The receiver incorporates novel filtering circuits to separate the transmitted signal from the heavy interference caused by the electrical sparking apparatus used to ensure continuous burning of the gas jets heating the oven.

The device is now being made commercially under licence.—*Engineering Section.*

New Maps of Australia's Soils

Since soil is one of our basic natural resources, the preparation of maps showing the distribution of the various groups is a project of great significance. Until now the only available soil maps of the Commonwealth were based on one produced in 1944. This year, however, has seen the compilation of a new map at a scale of 1 : 5 million (approximately 1 inch = 80 miles).

Progress has also been made with the projected Atlas of Australian Soils. This collection of maps at a scale of 1 : 2 million (approximately 1 inch = 30 miles) will eventually cover the whole country. The first of the series, dealing with the central portion of southern Australia, is now complete. The project is a long-term one but, when finished, it will indicate soil distribution in considerably greater detail than hitherto attempted for the whole continent.—*Division of Soils.*

Cobalt in Tasmanian Soils

On some cobalt-deficient pastures in Tasmania it may be cheaper to apply that element to the soil in fertilizer than to rely on alternative methods of preventing cobalt deficiency in grazing animals.

From early evidence it appears that many soils contain barely enough cobalt for the maintenance of healthy stock and, with the trend toward more intensive use of the land, it is possible that the supply in many soils will prove to be inadequate.

In cooperation with the Tasmanian Department of Agriculture, the Organization is investigating the cobalt status of Tasmanian soils. It is hoped to determine critical soil cobalt levels below which deficiency symptoms occur. The collected data should make possible the prediction of deficiency troubles before they actually occur.—*Division of Soils.*

Wash and Wear Woollen Garments

A method for producing washable non-iron effects in wool fabrics was released to industry at a trade meeting during the year. The meeting was well attended by representatives of the Australian textile industry. The method consists of first shrink-proofing the fabric, flat setting by steaming in the presence of sodium bisulphite, and finally drying with little or no tension to minimize subsequent relaxation shrinkage. The process has now reached commercial application in Australia, and treated shirts have already appeared on the market. The treatment has been covered by a registered trade mark: "SIRONIZED". In wearing trials, treated shirts have been worn and washed up to 200 times without sign of shrinkage or need for ironing. Concurrently with this work a new shrink-proofing treatment for wool has been brought to the stage of commercial application. The method is applicable to tops as well as woven and knitted fabrics, and should have wide application in producing articles such as washable knitwear and blankets.—*Division of Textile Industry.*

Woollen Blankets for Hospitals

Research has disproved the contention held by some medical authorities that fibres shed from wool blankets in hospitals are a major source of cross infection. Methods of sterilizing shrinkproofed wool blankets by boiling in a neutral detergent have been evolved, and the Royal Melbourne Hospital has collaborated in these investigations. This hospital has led in the change-over by many Australian hospitals to all-wool shrink-resistant blankets. It was the Royal Melbourne Hospital which originally drew the attention of the Organization to the seriousness of the cross-infection problem for hospitals and the then current view of medical authorities that woollen blankets were a significant contributory factor. Overseas this view has gained sufficient credence to seriously affect the future use of woollen blankets in hospitals.

The success of this work has led to further research on cross-infection problems in hospitals. Textile fibres may not be implicated to any extent, and other mechanisms of cross-infection will have to be investigated. It has certainly been established that the major fibres present in hospital dust are cotton and cellulose and not wool. On the average only 3 per cent. of fibres in hospital dust are wool.—*Division of Protein Chemistry.*

Australian Instrument Industry

There has been an increasing production in Australia of instruments designed in C.S.I.R.O. The following items are now in production: STACPAC, a regulated power supply; SI-RO-FLEX, a microtome for use in electron microscopy; hollow-cathode lamps and electronic units for use in atomic absorption spectroscopy. In addition, multiple monochromators and atomic absorption spectrophotometers continue to be produced by overseas manufacturers under licence by the Organization. Royalties received on these instruments now exceed $80,000. It is hoped that the production of spectroscopic instruments in Australia will be stimulated by the availability of diffraction gratings from the ruling engine now being constructed.—*Division of Chemical Physics.*

Prediction of Rainfall

The development of climatology in Australia during recent years has made it increasingly important to know, as accurately as possible, the position of rainfall isohyets. The whole problem is complicated by the paucity of observing stations in this country. Two new statistical techniques have now been developed designed to yield accurate spatial prediction of rainfall.

The first of these gives prediction in terms of position and altitude, suitable for regions up to 50 by 100 miles in area. This method was worked out in detail for the region in the immediate vicinity of Adelaide, and the Engineering and Water Supply Department of South Australia has already used the results in planning future extensions of Adelaide's metropolitan water storage.

The second technique gives prediction in terms of correlation with neighbouring stations, suitable for regions up to 200 by 800 miles in area. The detail of this method was worked out for a large zone comprising parts of South Australia and Victoria. In addition to supplying a means for predicting rainfall at points where there are no observing stations, this investigation has provided basic material for further study of the migratory anticyclones which traverse southern Australia from west to east and so profoundly affect rainfall of the region.—*Division of Mathematical Statistics.*

Polyethylene Box Liners for Stored Pears

The best methods of storing apples and pears employ gas-proof chambers in which the carbon dioxide and oxygen in the atmosphere surrounding the fruit can be controlled. Such stores are expensive to construct and maintain. A cheaper alternative method is to use a gas-proof liner inside each box in which the fruit is packed. In current investigations and commercial-scale trials, polyethylene box liners have significantly increased the storage life of four main varieties of pears. However, precautions must be taken to avoid excessive concentration of carbon dioxide and depletion of oxygen within the liners. Experiments are continuing, to extend this technique to the storage of Granny Smith, Jonathan, and Delicious apples.—*Division of Food Preservation and Transport.*

Presteaming of Timber

A new presteaming procedure has been developed which is greatly improving the drying of refractory timbers, and with some timber species is effecting a saving of 20 per cent. in the drying time required. Optimum steaming time for 1 in. thick material is 2 hr, at a temperature of 212°F. Present opinion is that the improved drying behaviour obtained is due to increased moisture conductivity, resulting from morphological or chemical modification in susceptible material. Studies have not yet advanced sufficiently to confirm this.—*Division of Forest Products.*

Timber Preservation by Dip Diffusion

Some years ago, the Organization developed a high-pressure impregnation treatment for eucalypts and other woods which would not treat at ordinary pressures. In subsequent tests, many species and products have been treated and these include some 5000 sleepers which have been installed in service tests. Recently, the first commercial high-pressure (1000 lb/sq. in.) plant was successfully started up by State Building Supplies, of Western Australia, for the production of treated karri crossarms and later some sleepers. For timbers which are too impermeable to be impregnated under pressure, the Division developed a dip-diffusion process using a very concentrated preservative. Unfortunately, it was always necessary to mix the treating chemicals where they were to be used, making supervision of the process difficult. This year, a new free-flowing preservative has been developed

which can be supplied in the premixed form, and this has simplified the application of the technique. The process is designed only for timber used in non-leaching locations but is suited particularly to house framing, flooring, etc. where the timber is not exposed unpainted or in contact with the ground.—*Division of Forest Products.*

Oolitic Iron Formations

The Organization has assisted in the exploration of extensive newly discovered oolitic iron formations of the Northern Territory. Microscopical examination of outcrop specimens, and of selected sections of drill cores from these occurrences, has revealed their texture and mineral composition. This led to the prediction that in the deeper-lying sections of the formation, carbonate minerals would take the place of the silica cements found in surface and near surface sections. Subsequent drilling has confirmed this, the carbonate proving to be the iron carbonate, *siderite*. In the Roper Bar area the first occurrence in Australia of the iron silicate, *greenalite*, was found, permitting a new chemical analysis and giving new X-ray powder data for this mineral. The oolitic siderite formations of the Constance Range promise a significant addition to Australia's iron ore reserves.—*Mineragraphic Investigations.*

Production of Alumina

The conventional method of making alumina is by the alkaline (or Bayer) process using bauxite as the source mineral. Progress has been made during the year with the development of an acid process for the production of alumina from various raw materials. Preliminary costing has been carried out for the new process using a flow sheet based on fully cyclic operation. Present indications are that reagent costs are considerably less than those for the conventional Bayer process, but that capital costs for the necessary corrosion-resistant equipment are high. Cheaper materials are being sought for constructing the plant, and improved chemical techniques will be adopted for the process to permit greater output for a given size of plant. The method shows promise of being readily applicable to clays and aluminous laterites, which cannot be treated economically by the alkaline Bayer process.—*Division of Mineral Chemistry.*

Composition of Waxes

Although sugar cane wax has been produced on a large scale for some 10 years there has been no exact information concerning its composition. It has now been found that the wax as it occurs on the cane consists principally of polymerized long-chain aldehydes, with lesser amounts of long-chain alcohols which were already known to be present. This disproves the belief that natural plant waxes should be largely mixtures of esters. Other natural waxes not composed largely of esters have been found previously, but none consisted principally of aldehydes. Aldehydes are very susceptible to chemical change and, in the process of crushing the cane and clarifying the expressed juice, the major part of them

suffers conversion to a mixture of substances including ketones, acids, and a little ester. This new information necessitates a reassessment of the commercial possibilities of this wax.

A study has also been made of the waxes that coat the tubercle and diphtheria bacteria. These waxes contain physiologically active components, and are available only in small quantity. The lengthy methods for determining structures have in the past made exact chemical knowledge of them difficult to obtain. By the use of a method which breaks up a molecule, carbon atom by carbon atom, and analyses the mixture of products obtained by gas chromatography, it has been possible to obtain this exact knowledge rapidly with very small quantities of material. The method should find application in solving other related problems.—*Organic Chemistry Section.*

Bush Fire Research

Special instruments have been designed and constructed and a mobile laboratory equipped for research on methods of bush fire prevention and control. Data are now being collected on the basic mechanisms of flame propagation and means of controlling fires. Meanwhile, several short-term projects have been undertaken designed to find ways of protecting and assisting persons using conventional fire control methods.—*Division of Physical Chemistry.*

Survey of Queensland Coals

Much attention has been directed to assessing the potentialities for industrial utilization of Queensland coals, particularly from the Blair Athol, Ipswich, and Kianga coalfields. Carbonization has been studied at high rates of heat transfer by the fluidized-bed process, using finely divided coal in a current of air or other gases at temperatures up to 700°C. The effect on yields of char and by-products of operating variables, such as carbonizing temperature, type of coal, and gas flow rates, were examined using a carbonizer with a capacity of 50 lb of coal an hour. Investigations have also shown that coal from the North Ipswich district of the West Moreton coalfield will give high-quality metallurgical coke provided the processing techniques which have been recommended are implemented.—*Division of Coal Research.*

Hardening of Brass

The extensive use of brass in industry has for a long time stimulated investigations into its structure and properties. Alpha brass and similar alloys harden on annealing at low temperatures after plastic deformation, in contrast to the behaviour of pure metals. Several explanations of this unusual behaviour have been suggested, but study completed in the Division of Tribophysics now allows an unequivocal answer to be given. Measurements were made of the internal energy, electrical resistivity, density, hardness, and flow stress of alpha brass after various quenching and annealing treatments, and in various stages of plastic deformation. It has been proved that alpha brass is "ordered" after slow

cooling treatments, and that the degree of order can be considerably increased by isothermal annealing at low temperatures. The contributions of order, vacancies, and dislocations to the behaviour of the alloy have been distinguished, and changes in properties on annealing, quenching, and deformation have been associated quantitatively with the extent of order and the density of crystal defects. Vacancies assist the reordering of the alloy after it has been disordered by deformation or quenching. The hardening of deformed alpha brass on annealing is due to the return of order, and the maximum hardness corresponds to the development of the maximum degree of order.—*Division of Tribophysics.*

Optical Definition of the Metre

The next General Conference in October 1960, of the International Bureau of Weights and Measures will consider adoption of the optical definition of the metre. The new primary standard of length employs selected spectral emissions as a basis for defining the metre, and study has been undertaken of the technology and instrumentation which will be involved in the change-over to the new standard. Equipment has been set up and extensively used for the precision study of wavelengths emitted by krypton 86, mercury 198, and cadmium 114 isotope light sources. All wavelength measurements and spectral line profile studies can be done under vacuum conditions. Vacuum wavelengths can be measured with very high accuracy, and small changes in wavelengths of the order of a few parts in 10^9 are measurable. This equipment establishes with high quantitative accuracy whether any given light wavelength is suitable as an optical standard of length.—*Division of Metrology.*

Germanium and Thorium Recovery

Work was completed on a method for recovery of germanium from the flue-dust of coal-burning power stations in Australia. Up to half a ton, per annum, of germanium can be recovered for use in transistors and similar electrical devices should this become necessary. Germanium is currently valued at £150,000 per ton. Progress was also made in devising improved processes for the recovery of thorium compounds from Australian minerals and new methods for preparing thorium metal were developed. This work is related to the role of thorium in nuclear reactors.—*Division of Mineral Chemistry.*

Structure of Large Molecules

X-ray methods have been further developed for the determination of the structures of large molecules, by the application of a high-power X-ray generator and by collecting intensity data at low temperatures. These techniques, which involve extensive use of electronic computers, have yielded detailed knowledge of molecular structure which is not obtainable by any other method. Work during the past year has included the determination of the structure of three alkaloids: himbacine hydrobromide, thelopogine methiodide, and jacobine bromhydrin.

Initial studies have been made on sporidesmin, which is responsible for the facial eczema disease in sheep.

The mass spectrometer has been further developed to investigate the binding energies within molecules. A significant advance has been made in the study of the disintegration of molecules when bombarded by high-energy electrons. The manner in which ionization varies with the excess energy of bombarding electrons above a threshold value depends on the degree of ionization. The fact that processes leading to different degrees of ionization follow different threshold laws has necessitated reconsideration of the methods used to calculate the ionization threshold energies. The theory of ionization curves has been extended to show that relative electronic transition probabilities can be obtained from the experimental data.—*Division of Chemical Physics.*

Reducing Evaporation of Water

A method of generating a protective film for the reduction of evaporation on large reservoirs by dusting solid hexadecanol has been extensively tested during the summer at Umberumberka (Broken Hill) and at Lake Corella (Mary Kathleen). The technique has been greatly simplified by the invention, by an officer of the Broken Hill Water Board working with C.S.I.R.O. staff, of a "grinder-duster" that is capable of taking solid blocks of hexadecanol, grinding them to powder, and distributing it. Results show very satisfactory reductions of up to 50 per cent. of the normal evaporation in still conditions, but when the wind velocity exceeds 5 m.p.h. the saving is very much less. Means of overcoming the influence of high winds are being studied.—*Division of Physical Chemistry.*

Solvent Degreasing of Wool

The Organization's solvent degreasing process for cleaning raw wool is now in full-scale commercial operation. It has been confirmed both in industry and the laboratory that solvent degreasing gives increased yields of wool compared with soap scouring. The difference in yield appears to be related to the type of fleece. Several trials on the woollen as distinct from the worsted system have shown that, after carbonizing, higher yields of wool are obtained by solvent degreasing than by soap scouring.

The pilot plant at Geelong has been remodelled to incorporate an improved type of conveyor, and these modifications, together with other improvements, have brought about a significant reduction in solvent consumption.—*Division of Textile Physics.*

Improvements in Instrumentation for Physical Standards

Progress has been made during the year in the development of a number of standards and instrument techniques. Work on the photoelectric disappearing filament optical pyrometer has led to improvement in setting accuracy at 1100°C by a factor of about 40, as compared with the best conventional visual instruments. Attention is being given to the reproducibility of various melting points as

possible substitutes for primary or secondary fixed points on the International Temperature Scale. In hygrometry there has been continuous instrument development, with research into related vapour pressure and condensation phenomena. Work has also continued on the exploitation of the improved accuracy achievable with flared-capillary viscometers. Equipment has been brought into operation for the quantitative assessment of optical image quality, while work on exceedingly narrow-band interference filters has enabled interference fringes to be obtained with path differences of many metres. Investigations have continued on conduction phenomena in, and specific heats of, metals and alloys, and this work has been extended to include coefficients of expansion. A new type of spectrometer, operating at zero magnetic field, has provided a powerful new technique in paramagnetic resonance studies.—*Division of Physics.*

Wool Sampling Tool

A set of pressure coring tools recently developed for cutting sample cores from baled wool has now been presented to the Australian Wool Testing Authority. With these tools the same staff is now able to sample twice as many bales as was possible with the old rotary coring equipment. Wide interest in the new sampler has been evinced overseas, and arrangements have been made for the Australian Wool Testing Authority to be the Organization's manufacturing and distributing agents for this equipment. A patent application has been filed in Australia for the new coring tool.—*Division of Textile Physics.*

Electrodynamic Lifting of the Ionosphere

Since the war it has been known that the distribution of ionization in the *F* region of the ionosphere (the region responsible for all long-distance short-wave radio communications) is highly anomalous near the equator. An early suggestion by C.S.I.R.O. was that this was due to electrodynamic lifting of the ionosphere at the geomagnetic equator, followed by diffusion of the ionization along the geomagnetic field lines to higher latitudes. This suggestion has now been quantitatively examined and appears to be substantiated.—*Upper Atmosphere Section.*

Radio Noise

During the year apparent natural sources of very low frequency radio noise have been located. By direction-finding methods from receivers located at Hobart, Salisbury (S.A.), and Camden (N.S.W.), it was found that these were sometimes areas of about 700 km average diameter south of the Australian continent. These areas appeared to be irradiated by correspondingly limited regions high above the atmosphere, the radiation penetrating the ionosphere by travelling down the geomagnetic field lines, and spreading out horizontally at lower levels. This work has aroused much interest abroad, and the United States National Aeronautics and Space Administration (N.A.S.A.) has undertaken to house Australian detectors of very low frequency radio noise in its Scout satellite vehicle, to study the distribution of all noise sources in the spatial environment of the Earth.—*Upper Atmosphere Section.*

Radioactive Debris in the Stratosphere

Measurements on radioactivity of rainwater have provided valuable information on the world problem of how the stratospheric debris from nuclear explosions travels and spreads before falling to earth. The clouds suffer only limited dispersion and retain their identity for months, showing evidence of a slow poleward drift at stratospheric levels.—*Division of Meteorological Physics.*

Evapotron

The first model of the "Evapotron", an instrument designed to yield direct readings of evaporation from natural surfaces on the eddy-flux principle, has now been completed. Short-period evaporation over open grassland was measured in proving tests to an accuracy of a few per cent. A transistorized version, designed for ultimate commercial production, is ready for testing. Experiments on the estimation of evaporation from Lake Eucumbene by other, less direct, methods have also been completed, with the verification of a simple method which may now be adopted for routine use. The prototype recorder, designed to run unattended for long periods and provide records of water level or meteorological elements, has successfully completed a 15 month field trial. Twelve manufactured instruments are being more widely tested for a year by various interested bodies before unlimited commercial production is authorized.—*Division of Meteorological Physics.*

Stability of Natural Slopes

The existence of active landslips in the firm sediments of parts of northern Tasmania has stimulated detailed investigations on the stability of natural slopes—particularly in areas used for residential and industrial purposes. In major zones of instability, movements of discernible or damaging magnitude appear to occur only in minor areas, although ample morphological evidence is available to suggest an almost universal pattern of active slipping within the present geological period. The critical requirement in such landslip investigations therefore is definition of a time scale for movements of various magnitudes, rather than determination of the ultimate stability of the slopes. The problem of calculating these rates of movement has not been solved, but a survey procedure to define actual movements has been advanced and will be implemented during the coming year.—*Soil Mechanics Section.*

Calculable Capacitor and Absolute Determination of the Ohm

In precise determinations of the ohm by various national laboratories, the starting point has been an inductance whose value is calculated from its measurements. Various experiments in recent years have considerably improved the accuracy to which the velocity of light is known. This has revived interest in developing a capacitor, the value of which can be calculated from its dimensions.

With this as a starting point the absolute value of the ohm can be determined by using the velocity of light to convert this capacitance, calculated in electrostatic units, into electromagnetic units. C.S.I.R.O. has been designing and constructing a calculable capacitor. This has now been completed, and special techniques and equipment have been devised to determine its characteristics. The associated project of the absolute determination of the ohm is also well advanced. This project, when completed, will make Australia self-sufficient in this particular field of standards work, and will also make a valuable contribution to the accurate determination of the primary electrical standards.—*Division of Electrotechnology.*

Chemical Engineering Research

A pilot plant has been designed and installed for the hydrogenation of brown coal by the fluidized-bed process. The plant employs countercurrent contact between coal and hydrogen-rich gas in a 20 ft deep baffled fluidized bed.

A detailed evaluation has been made of available techniques for desalination of sea-water. With present-day technology, it is clear that very large plants with outputs in excess of 40,000,000 gal per day of water, together with by-product electricity, employing nuclear reactors as the heat source, could produce at the cost of 8–9 shillings (Australian) per 1000 gallons.—*Chemical Engineering Section.*

Phosphorescence

Understanding of the phenomena of phosphorescence is not only of direct industrial importance but is necessary in basic studies in solid state chemistry. Experimental techniques have now been developed which represent a marked advance on previous work in this field. Already new conceptions of phosphorescence have emerged. The results obtained suggest that energy stored in phosphors may be released as luminescence through a number of parallel internal channels, and that distribution of energy between these channels varies with temperature in a way which is not in accord with current theory. This is the first direct experimental evidence that such channels exist. It seems likely that further results will lead to a more complete model of the mechanisms responsible for the phenomenon of phosphorescence.—*Division of Chemical Physics.*

Reducing Stored Food Wastage

The traditional method for retarding non-enzymic browning of stored food is by the addition of sulphur dioxide or bisulphite. The mechanism of inhibition has never been clearly understood, but investigations have now shown that the role of bisulphites may be due to the oxidation of the carbonyl compounds formed in the aldose-amine reactions preceding browning. This could represent an important advance in current endeavours to reduce wastage of stored foods

spoiled by non-enzymic browning. Proper understanding of the mechanism by which sulphur dioxide and bisulphite inhibit browning may lead to improved methods for preventing spoilage.—*Division of Food Preservation and Transport.*

Unsaturated Soils

The engineering characteristics of unsaturated soils are of special interest in Australia because of soil conditions resulting from the semi-arid nature of much of this country.

Ways to express these engineering characteristics have now developed in terms interpretable to other soil mechanics groups and measurable in appropriate laboratories. Agreement has been recorded between parallel work in Australia and other countries, notably England and South Africa, and a common approach to measurement and notation has been developed.—*Soil Mechanics Section.*

Wear in Sheep's Teeth and Rumen

A collaborative investigation with the Department of Agriculture, University of Melbourne, has shown that opal phytoliths (plant opal) and mineral matter—previously shown to be a major causal factor in the wear of sheep's teeth—are also a likely cause of wear of the papilli and the endothelial layer of the rumen. They have been detected in lymph nodes of the sheep, and in siliceous uroliths ("calculi") of a stud ram. "Animal opal" formed a large part of the uroliths, and was present also in phagocytes and macrophages in the lymph nodes of sheep.—*Mineragraphic Investigations and Division of Plant Industry.*

Coking Properties of Pitch

A study has been made of the coking properties of pitch from Australian gas-works tars. The purpose of this investigation has been to develop methods for producing the binders which are essential in the manufacture of electrodes for tha aluminium industry. Study of the chemical structure of pitch showed that the coke-forming properties of its higher molecular weight fractions are related, not only to molecular size, but also to the concentration of active centres such as phenolic hydroxyl groups.—*Division of Coal Research.*

Stretched Tendons

An interesting result emerging from fundamental study of the physics of wool has been the existence of a transition temperature, above which irreversible change takes place if the wool fibre is strained. This work has been extended by showing that fibres of animal tendon also have a transition temperature. For tendon it is only slightly above normal blood temperature. This suggests that tendons could be damaged by heavy exertion when suffering from a fever, and that such damage may be the origin of some rheumatic complaints.—*Division of Textile Physics.*

3

Published Papers

The following papers have been published during the year. Letters Patent granted to C.S.I.R.O. during the year are also included.

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DIVISION OF TEXTILE INDUSTRY

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4

Finance

A summary of the Organization's receipts and expenditure from July 1, 1959 to June 30, 1960 has been given on page 18. Details are given below:

Expenditure

	£	£	£
Salaries and Contingencies*			**362,188**
Investigations			
Animal Research Laboratories		898,477	
LESS contributions from—			
Wool Research Trust Fund Trust Account	411,096		
Australian Dairy Produce Board	1,746		
Commonwealth Bank	3		
United Graziers' Association of Queensland	1,207		
J. R. Allen	200		
Ian McMaster Bequest	2,740		
Alexander Fraser Memorial Fund	277		
Various Contributors	47		
W. McIlrath Fellowship	2,250		
Burdekin Bequest (Drought feeding)	388		
The Population Council Inc.	3,441		
Australian Meat Board	6		
Special Revenue Funds—			
"Belmont" Field Station	12,291		
Burdekin Bequest	2,291	437,983	460,494
Plant Research—			
Plant Industry		814,116	
LESS contributions from—			
Wheat Research Trust Account	4,676		
Brown Rot Trust Fund	1,298		
Rockefeller Foundation	5,256		
Wool Research Trust Fund Trust Account	177,796		
River Murray Commission	1,875	190,901	623,215

* The main items of expenditure under this heading are salaries of the administrative staff at Head Office; salaries and expenses of officers at the Liaison Offices in London and Washington; staff and upkeep of State Committees; travelling expenses of Head Office Staff; and general office expenditure.

	£	£	£
Tropical Pastures		159,849	
LESS contributions from—			
Rockefeller Foundation	4,950		
Various Contributors	579		
Special Revenue Fund—			
Samford Farm	274	5,803	154,046
Suspense (Overseas transactions)			1,742
Entomology		340,185	
LESS contributions from—			
Department of Primary Industry	10,913		
United Graziers' Association, Australian Meat Board	972		
Wheat Research Trust Account	28		
U.S.A. Department of Health	3,337		
Dairy Produce Research Trust Account ..	1,669		
Australian Dairy Produce Board	897	17,816	322,369
Soils and Irrigation—			
Soils		273,433	
LESS contributions from—			
Broken Hill Associated Smelters Pty. Ltd. ..	250		
S. Aust. Woods and Forests Department ..	270		
Various Contributors	9		
Australian Petroleum Exploration Association Ltd.	196	725	272,708
Soil Mechanics		46,910	
LESS contributions from—			
Department of the Army	3,825		
Various Contributors—Subgrade Moisture Investigations	995		
Launceston City Council	1,625		
British Conference Account	290		
Various Contributors — Research on Building Foundations	105	6,840	40,070
Commonwealth Research Station, Merbein ..		86,919	
LESS contributions from—			
Dried Fruits Control Board	1,096		
Packing Companies and Co-operative Dried Fruit Sales Pty. Ltd.	1,035	2,131	84,788
Irrigation Research Station, Griffith		85,629	
LESS contributions from—			
N.S.W. Water Conservation and Irrigation Commission	2,000		
Special Revenue Fund—			
Griffith Research Station	7,288	9,288	76,341
Suspense (Overseas transactions)			2,428

	£	£	£
Food Preservation and Transport		290,600	
LESS contributions from—			
N.S.W. Department of Agriculture	1,815		
Metropolitan Meat Industry Board	510		
Queensland Meat Industry Board	1,275		
Australian Meat Board	726		
Australian Egg Board	682		
Department of Primary Industry	3,594		
Department of the Army	187		
Various Contributors	1,870		
Apple and Pear Board	84		
Egg Producers' Council	1,000	11,743	278,857
Forest Products		376,414	
LESS contributions from—			
Australian Paper Manufacturers Ltd. Associated Pulp and Paper Mills Ltd. Australian Newsprint Mills New Zealand Forest Products Ltd.	7,230		
Department of Territories	3,315		
General Donations	2,345		
Pole Strength Research Account	2,397		
Australian Plywood Board	7,256	22,543	353,871
Mining and Metallurgy		60,300	
LESS contributions from—			
Australasian Institute of Mining and Metallurgy	397		
Consolidated Zinc Pty. Ltd.	1,201		
General Donations	4,307	5,905	54,395
Radio Research—			
Upper Atmosphere Section			30,524
Radio Research Board Activities		31,617	
LESS contributions from—			
Postmaster-General's Department Australian Broadcasting Control Board Overseas Telecommunications Commission		16,617	15,000
Research Services		383,321	
LESS contributions from—			
Wool Research Trust Fund Trust Account	16,789		
Wheat Research Trust Fund	11,126	27,915	355,406

	£	£	£
Chemical Research Laboratories		829,199	
LESS contributions from—			
Cement and Concrete Association of Australia	5,067		
State Electricity Commission of Victoria, Gas and Fuel Corporation of Victoria, Australian Paper Manufacturers Ltd.	6,294		
Various Contributors	3,696		
Smith, Kline, and French Laboratories (U.S.A.)	6,397		
Commonwealth Aluminium Corporation	1,170		
Chamber of Mines (W.A.) Inc.	2,771		
The Population Council Inc.	1,106		
Consolidated Zinc Pty. Ltd.	64		
Wool Research Trust Fund Trust Account	34,968	61,533	767,666
Fisheries and Oceanography		237,192	
LESS contributions from—			
Fisheries Development Trust Fund	10,085		
Department of the Navy	4,682		
Department of Primary Industry	901		
N.S.W. State Fisheries Department	377		
Bureau of Mineral Resources	1,533	17,578	219,614
Mathematical Statistics			80,651
National Standards Laboratory		738,373	
LESS contribution from—			
Department of Supply		1,733	736,640
Tribophysics		118,614	
LESS contribution from—			
H. C. Sleigh Ltd.		1,392	117,222
Building Research		177,343	
LESS contributions from—			
Associated Fibrous Plaster Manufacturers of Australia, Australian Plaster Industries Ltd., Colonial Sugar Refining Co. Ltd.	3,042		
Paint Manufacturers' Association	1,244		
State Electricity Commission	24		
Cement and Concrete Association of Australia	1,596		
State Rivers and Water Supply Commission	31	5,937	171,406
Biochemistry and General Nutrition		151,459	
LESS contributions from—			
Wool Research Trust Fund Trust Account	53,490		
Australian Wool Board (old grant)	639	54,129	97,330

	£	£	£
Fodder Conservation			36,691
Radiophysics		436,273	
LESS contributions from—			
Snowy Mountains Hydro-Electric Authority ..	3,106		
Department of Civil Aviation	7,041	10,147	426,126
Metallurgical Research			13,063
Tobacco Research		53,730	
LESS contribution from—			
Tobacco Research Trust		53,730	NIL
Meteorological Physics		110,091	
LESS contribution from—			
Donations Account		12	110,079
Dairy Research		93,364	
LESS contributions from—			
Australian Dairy Produce Board	1,214		
Dairy Produce Research Trust Account ..	13,433	14,647	78,717
Wool Research		517,344	
LESS contributions from—			
Wool Research Trust Fund Trust Account ..	474,912		
Wool Buying and Selling Account	5,179		
Australian Wool Bureau	5,145		
Second International Wool Textile Research Conference	19,471	504,707	12,637
Fuel Research			242,023
Wildlife Survey		154,528	
LESS contributions from—			
Wool Research Trust Fund Trust Account ..	53,271		
Australian Newsprint Mills Pty. Ltd.	1,327		
Petfoods Ltd.	7		
I.C.I.A.N.Z. Ltd.	54	54,659	99,869
Land Research and Regional Survey		295,507	
LESS contributions from—			
Department of National Development ..	3,222		
Department of Territories	78,095		
Australian Meat Board	26	81,343	214,164

	£	£	£
Genetics Investigations		75,836	
LESS contribution from—			
Wool Research Trust Fund Trust Account ..		37,360	38,476
Miscellaneous—			
Biophysical Research	2,400		
Patent Fees	5,096		
Extra-mural Investigations	32,598		
Furlough and Compensation	28,065		
Wheat Research	21,086		
Second International Wool Textile Research Conference	9,450		
Various	11,034	109,729	
LESS contributions from—			
Science and Industry Endowment Fund ..	3,266		
Wheat Research Trust Account	21,086		
Wool Research Trust Fund Trust Account ..	9,450	33,802	75,927
TOTAL Investigations			**6,664,555**
Grants			
Research Associations—			
Leather Research Association	5,337		
Bread Research Institute	15,250		
Wine Research Institute	3,500		
Tobacco Research Trust	10,500		
Coal Association (Research) Ltd.	20,000	54,587	
Overseas Research Studentships		91,639	
		146,226	
LESS contributions from—			
Wool Research Trust Fund Trust Account ..	4,444		
Science and Industry Endowment Fund ..	1,646	6,090	**140,136**
TOTAL Salaries and Contingencies, Investigations, and Grants			**7,166,879**
LESS receipts from sales of equipment, publications, etc., and revenue earned by Divisions and Sections, details of which are shown on page 102			96,676
			7,070,203

Contributions

This Section shows receipts and disbursements during the year 1959–60 of the funds provided by contributors and recorded in a special account entitled "Specific Research Trust Fund". It includes transactions financed from wool funds, details of which appear on pages 100–2. Of the total expenditure of £2,007,938 recorded in this Fund, £1,695,281 refers to normal research activities and £312,657 to capital works.

The following table summarizes the sources of these funds and the activities on which they were expended:

SOURCE OF FUNDS	ACTIVITY *Investigations*	*Capital Works*	TOTAL
	£	£	£
Wool Research Trust Fund Trust Account	1,273,575	209,801	1,483,376
Contributions (in addition to Wool)	421,706	102,856	524,562
	1,695,281	312,657	**2,007,938**

The details are as follows:

	Receipts 1959–60 & Balances brought forward 1958–59 £	*Expenditure 1959–60* £
Wool Research Trust Fund Trust Account (*details are shown on pages* 100–2)	1,522,596	1,483,376
Australian Dairy Produce Board—*Mastitis Investigations*	2,066	1,743
W. McIlrath Research Fellowship Fund—*Expenses of Fellowship, Animal Husbandry*	2,250	2,250
Australian Meat Board—*Parasitological Studies of Cattle*	6	6
Australian Dairy Produce Board—*Parasitological Studies of Cattle*	3	3
Alexander Fraser Memorial Fund (Animal Research Laboratories)	722	277
Estate of the late Captain Ian McMaster (Animal Research Laboratories)	3,300	2,740
Burdekin Bequest—*Drought Feeding Investigations* ..	4,023	388
Special Revenue Fund—"*Belmont*" *Field Station, Rockhampton, Qld.* (Animal Research Laboratories) ..	38,494	12,291
General Donations (Animal Research Laboratories) ..	50	47
Special Revenue Fund—Burdekin Bequest (Animal Research Laboratories)	3,199	2,291
United Graziers' Association of Queensland (Animal Research Laboratories)	3,235	1,207
J. R. Allen, Mortlake, Vic. (Animal Research Laboratories)	200	200
Trust Fund Brown Rot Investigations—*Brown Rot Survey* (Plant Industry)	1,600	1,298
General Donations (Plant Industry)	50	NIL
Western Australian Golf Association (Plant Industry) ..	50	NIL
River Murray Commission (Plant Industry)	1,875	1,875

	Receipts 1959–60 & Balances brought forward 1958–59	*Expenditure 1959–60*
	£	£
Australian Tobacco Research Trust—*Tobacco Investigations*	53,811	53,730
Rockefeller Foundation (Plant Industry)	10,665	5,256
Rockefeller Foundation (Tropical Pastures)	13,332	4,950
Special Revenue Fund—*Grazing Trials, Samford Farm* (Tropical Pastures)	675	274
Various Contributors—*Soya Bean Harvester* (Tropical Pastures)	800	579
United Graziers' Association of Queensland and Australian Meat Board—*Cattle Tick Investigations* (Entomology)	972	972
Department of Primary Industry—*Fruit Fly Investigations* (Entomology)	13,458	10,913
U.S.A. Department of Health, Education, and Welfare—*Multiplication of an Insect Polyhedron Virus* (Entomology)	4,828	3,337
General Donations (Entomology)	22	NIL
Snowy Mountains Hydro-Electric Authority and River Murray Commission (Entomology)	500	NIL
Australian Dairy Produce Board—*Black Beetle Investigations* (Entomology)	1,000	897
Department of the Army (Soil Mechanics Investigations)	12,050	3,825
Department of Works and the States' Roads Boards—*Subgrade Moisture Investigation* (Soil Mechanics Investigations)	4,000	995
General Donations (Soil Mechanics Investigations)	16	NIL
Australian Petroleum Exploration Association Ltd.—*Microbiological Prospecting for Oil* (Soils Investigations)	NIL	195*
British Conference Account (Soil Mechanics Investigations)	300	291
S.A. Woods and Forests Department (Soils Investigations)	320	270
General Donations (Soils Investigations)	250	250
Commonwealth Fertilisers and Chemicals Ltd., Cuming Smith & Mt. Lyell Farmers Fertilisers Ltd., and Australian Fertilizers Ltd. (Soils Investigations)	1,000	9
Various Contributors—*Building Foundations in South Australia* (Soil Mechanics Investigations)	3,420	105
Launceston City Council—*Landslip Investigations* (Soil Mechanics Investigations)	1,695	1,625
N.S.W. Water Conservation and Irrigation Commission—*Maintenance of Griffith Research Station*	2,000	2,000
Packing Companies and Cooperative Dried Fruit Sales Ltd.—*Dried Vine Fruits Investigations* (Merbein)	2,514	1,035
Dried Fruits Control Board—*Dried Fruits Investigations*	2,107	1,096
Nyah–Woorinen Dried Fruits Inquiry Committee—*Dried Fruits Investigations*	525	NIL
Special Revenue Fund—*Citricultural Investigations* (Research Station, Griffith)	16,051	7,288

* Expenditure on this work will be recovered in 1960–61.

	Receipts 1959–60 & Balances brought forward 1958–59	*Expenditure 1959–60*
	£	£
Australian Meat Board (Meat Investigations)	4,874	726
Metropolitan Meat Industry Board of New South Wales—*Meat Investigations*	511	510
Queensland Meat Industry Board—*Meat Investigations* ..	1,276	1,276
Department of the Army—*Mutton Dehydration Investigations*	187	187
Department of Primary Industry—*Fruit Fly Investigations, Food Investigations*	3,650	3,234
Apple and Pear Board—*Food Investigations*	502	84
Dairy Produce Research Trust Account (Entomology) ..	1,700	1,669
Egg Producers' Council (Food Preservation and Transport)	NIL	1,000*
Various Contributors (Food Preservation and Transport)	8,855	1,870
Australian Egg Board—*Egg Investigations* (Food Preservation and Transport)	823	682
Department of Primary Industry—*Spray Residue Investigations* (Food Preservation and Transport) ..	450	360
N.S.W. Department of Agriculture—*Fruit Storage Investigations* (Food Preservation and Transport) ..	2,309	1,815
Paper Companies and New Zealand Forest Products—*Paper Pulp Investigations*	9,022	7,230
Sundry Contributors—*Forest Products Investigations* ..	6,183	2,345
General Donations—*Pole Strength Research* (Forest Products)	2,397	2,397
Department of Territories—*Development of Pulp and Paper Industry in New Guinea*	3,621	3,315
Australian Plywood Board—*Veneer, Gluing, and Plywood Research* (Forest Products)	7,853	7,256
Australasian Institute of Mining and Metallurgy (Mineragraphic Investigations)	1,000	397
Consolidated Zinc Pty. Ltd. (Ore-dressing Investigations)	1,201	1,201
General Donations (Ore-dressing Investigations) ..	7,067	4,307
Northwest Tantalum N.L. and Consolidated Zinc Pty. Ltd. (Ore-dressing Investigations)	2,000	NIL
State Electricity Commission of Victoria—*Geological Consultations* (Mineragraphic Investigations) ..	1,870	NIL
Miscellaneous Contributors (Mineragraphic Investigations)	116	NIL
Postmaster-General's Department, Australian Broadcasting Control Board, and Overseas Telecommunications Commission—*Radio Research Board Activities* ..	19,000	16,617
Consolidated Zinc Pty. Ltd. (Chemical Research Laboratories)	191	64
Miscellaneous Contributors (Chemical Research Laboratories)	9,865	3,696
State Electricity Commission, Gas and Fuel Corporation, and Australian Paper Manufacturers Ltd.—*Clinkering of Brown Coal Ash* (Chemical Research Laboratories)	6,159	6,294†

* Expenditure on this work will be recovered in 1960–61.

† Expenditure on this work in excess of receipts will be recovered in 1960–61.

	Receipts 1959–60 & Balances brought forward 1958–59	*Expenditure 1959–60*
	£	£
Commonwealth Aluminium Corporation—*C.Z. Project* (Chemical Research Laboratories)	1,174	1,170
Western Australia Chamber of Mines (Inc.)—*Cyanidation of Gold* (Chemical Research Laboratories) ..	3,657	2,771
Cement and Concrete Association of Australia—*Cement Investigations* (Chemical Research Laboratories) ..	11,325	5,067
Smith, Kline, and French Laboratories, U.S.A.—*Phytological Survey and Drug Plant Collection* (Chemical Research Laboratories)	11,864	6,397
N.S.W. Government—*Fisheries Investigations*	502	377
Department of the Navy—*Marine Fouling Investigations* (Fisheries and Oceanography)	6,318	4,682
Department of Primary Industry—*Pearl Shell Survey* (Fisheries and Oceanography)	904	901
Fisheries Development Trust Fund—*Barracouta Investigations* (Fisheries and Oceanography)	6,108	10,085*
Department of Supply—*Examination of Gauges* (Metrology)	1,733	1,733
General Donations (Physics)	40	NIL
Bureau of Mineral Resources (Fisheries and Oceanography)	NIL	1,533†
Miscellaneous Contributors (Mathematical Instruments Section)	126	NIL
General Donations (Metrology)	610	NIL
Machinability Donations Account (Metrology) ..	114	NIL
General Donations (Electrotechnology)	38	NIL
General Donations (Tribophysics)	205	NIL
H. C. Sleigh Ltd.—*Research on Solid Lubricants* (Tribophysics)	2,545	1,392
State Electricity Commission—*Design and Use of Briquette Space Heaters* (Building Research)	528	24
Associated Fibrous Plaster Manufacturers of Australia, Australian Plaster Industries, and Colonial Sugar Refining Co. Ltd.—*Fibrous Plaster Research* (Building Research)	3,414	3,042
Paint Manufacturers' Association—*Paint Research on Plaster Surfaces* (Building Research)	1,384	1,244
General Donations (Building Research)	3,532	NIL
Cement and Concrete Association of Australia (Building Research)	2,000	1,596
Australian Wool Board—*Balance of Old Grant, Sheep Research* (Biochemistry and General Nutrition) ..	778	639
Various Contributors (Biochemistry and General Nutrition)	750	NIL
Radio Astronomy Trust (Radiophysics)	102,856	102,856
Snowy Mountains Hydro-Electric Authority—*Cloud Seeding Investigations* (Radiophysics)	3,106	3,106
Department of Civil Aviation—*Radio Navigational Aids* (Radiophysics)	15,985	7,041

* Expenditure on this work in excess of receipts will be recovered in 1960–61.
† Expenditure on this work will be recovered in 1960–61.

	Receipts 1959–60 & Balances brought forward 1958–59	*Expenditure 1959–60*
	£	£
Various Contributors—*Rain and Cloud Physics Research* (Radiophysics)	8,000	NIL
State Rivers and Water Supply Commission, Vic. (Building Research)	NIL	31*
Committee for Dried Fruit Marketing (Meteorological Physics)	12	12
Australian Dairy Produce Board—*Cheese-making Project* (Dairy Research)	16	16
Dairy Produce Research Trust Account (Dairy Research)	18,635	13,433
Australian Dairy Produce Board—*Studentship in Dairy Chemistry* (Dairy Research)	1,108	700
Australian Dairy Produce Board—*Mechanization of Cheese Manufacture* (Dairy Research)	498	498
James Bell Machinery Pty. Ltd.—*Mechanization of Cheese Manufacture* (Dairy Research)	15	NIL
Wool Buying and Selling Account (Wool Research Laboratories)	7,997	5,179
Donations for Worsted Processing Research (Wool Research Laboratories)	179	NIL
Shell (Chemical) Aust. Pty. Ltd.—*Mothproofing Investigations* (Wool Research Laboratories)	27	NIL
G. C. Firth—*Solvent Degreasing Trial* (Wool Research Laboratories)	Dr. 92	Cr. 92
Associated Woollen Worsted Textile Manufacturers of Australia (Wool Research Laboratories)	2,032	NIL
Various Contributors—*First International Wool Textile Research Conference*	50	NIL
Wool Research Development Fund—*Research Development and Industrial Liaison* (Wool Research)	5,150	5,145
General Donations (Wool Research)	630	NIL
Princeton Institute, U.S.A.—*Princeton Wool Project* (Wool Research)	2	NIL
Second International Wool Textile Research Conference ..	18,900	19,471†
General Donations—*Coal Investigations*	2,436	NIL
Petfoods Ltd.—*Food for Budgerigars* (Wildlife Survey) ..	100	7
I.C.I.A.N.Z. Ltd.—*Duck Banding Investigations* (Wildlife Survey)	54	54
Australian Newspring Mills Pty. Ltd.—*Effect of Native Fauna on Eucalypt Regeneration* (Wildlife Survey) ..	1,358	1,327
Department of National Development—*Kimberley Research Station* (Land Research and Regional Survey)	3,236	3,222
Department of Territories—*Resources Survey in Papua and New Guinea* (Land Research and Regional Survey)	31,611	30,716
Australian Meat Board—*Pasture Development in Central Australia* (Land Research and Regional Survey) ..	31	26
Northern Territory Administration—*Rice Research* (Land Research and Regional Survey)	46,240	47,379*

* Expenditure on this work will be recovered in 1960–61.

† Expenditure on this work in excess of receipts will be recovered in 1960–61.

	Receipts 1959–60 & Balances brought forward 1958–59	*Expenditure 1959–60*
	£	£
General Donations—*Genetics Investigations*	232	NIL
Sundry Contributors (Commonwealth Scientific and Industrial Research Organization)	49	NIL
Science and Industry Endowment Fund	4,912	4,912
Wheat Research Trust Account	47,163	37,280*
The Population Council Inc.—*Studies on Induced Infertility*	12,979	4,547
Commonwealth Bank—*Genetics Investigations*	3	3
	2,227,871	**2,007,938**

Wool Research Trust Fund Trust Account

Details of transactions during 1959–60 are as follows:

	£	£	£
RECEIPTS			
Balance brought forward from 1958–59			32,596
Received from Department of Primary Industry during 1959–60			1,490,000
TOTAL			**1,522,596**
EXPENDITURE 1959–60			
Investigations			
Biological Research—			
Animal Research Laboratories—			
Sheep Biology Laboratory, Prospect, N.S.W. ..	243,755		
McMaster Laboratory	33,702		
Divisional Field Stations	15,472		
Regional Laboratory and "Chiswick" Field Station, Armidale, N.S.W.	68,543		
Tooradin, Vic.	6,633		
National Field Station, "Gilruth Plains", Qld. ..	41,717		
Suspense (Overseas transactions)	1,274	411,096	
Plant Industry—			
Headquarters, Canberra	53,345		
Regional Pastoral Laboratory and Falkiner Memorial Field Station, Deniliquin, N.S.W. ..	28,839		
Field Investigations, Armidale, N.S.W. ..	45,900		
Western Australian Investigations	49,683		
Suspense (Overseas transactions)	29	177,796	
Research Services—			
Agricultural Research Liaison Section.. ..	14,971		
Wool Publications	1,818		
		16,789	

* Includes £363 for 1958–59 which was underdebited in that year.

	£	£	£
Division of Biochemistry and General Nutrition—			
Nutrition Laboratory, Adelaide	23,660		
Field Studies at Glenthorne, Robe, and Brecon, S. Aust.	29,829		
		53,489	
Wildlife Survey Section—			
Wildlife Investigations		53,271	
Animal Genetics Section—			
Animal Genetics Investigations		37,360	
Overseas Studentships		3,300	753,101
Wool Research—			
Wool Research Laboratories—			
Protein Chemistry, Melbourne	156,465		
Textile Physics, Sydney	136,369		
Textile Industry, Geelong, Vic.	179,114		
Suspense (Overseas transactions)	2,964	474,912	
Chemical Research Laboratories—			
Chemical Physics	19,188		
Physical Chemistry	5,810		
Organic Chemistry	9,970	34,968	
Overseas Studentships		1,144	
Second International Wool Textile Research Conference		9,450	520,474
TOTAL Investigations			**1,273,575**
Capital Works			
C.S.I.R.O. EXPENDITURE			
Biological Research—			
Animal Research Laboratories—			
Laboratory Equipment	7,729		
Plant Industry—			
Laboratory Equipment	3,774	11,503	
Wool Research—			
Wool Research Laboratories—			
Laboratory Equipment	29,979		
Textile Machinery	67,058		
Solvent Degreasing Project	3,309	100,346	111,849
EXPENDITURE ON C.S.I.R.O. BUILDINGS BY DEPARTMENT OF WORKS			
Biological Research		78,357	
Wool Research		11,706	90,063

	£	£	£
EXPENDITURE ON BUILDINGS BY C.S.I.R.O.			
Biological Research		3,512	
Wool Research		4,377	7,889
TOTAL Capital Works			**209,801**
TOTAL Expenditure			**1,483,376**
BALANCE carried forward to 1960–61			**39,220**
			1,522,596

During the year £87,104 was received from sales of sheep, wool, and other produce from C.S.I.R.O. Field Stations and Laboratories financed from wool funds. This amount was paid to the Department of Primary Industry for credit to the Wool Research Trust Fund Trust Account.

Miscellaneous Receipts

During 1959–60 miscellaneous receipts amounted to £96,676. Details of the receipts are as follows:

	£
Sale of Publications	6,285
Sale of Equipment Purchased in Former Years, and Other Receipts	33,261
Sale of Produce by Field Stations and Laboratories ..	54,186
Royalties from Patents	2,944
	96,676

The receipts from the sale of produce represent revenue earned by Divisions and Sections apart from the Special Revenue included under Contributions.

The amount of £96,676 was credited to the Treasury appropriation and consequently reduced the requirements from the Treasury by that amount (*see* Expenditure).

Works Projects (under control of C.S.I.R.O.)

Treasury expenditure on works projects financed from funds made available directly to C.S.I.R.O. is as follows:

	£	£
Plant Industry		
Ginninderra Experiment Station	12,337	
Development of the Phytotron	32,570	44,907
Tropical Pastures		
Cunningham Laboratory	1,319	
Samford Farm	666	1,985

	£	£
Food Preservation and Transport		
Homebush Laboratory		981
Chemical Research Laboratories		
Site plan at Monash University	2,500	
Fishermen's Bend Laboratories	960	3,460
Fisheries and Oceanography		
Cronulla Laboratory		4,955
Electrotechnology and Metrology		
Alteration to Premises at Newtown		4,000
Meteorological Physics		
Lysimeter Project, Aspendale		5,118
Fuel Research		
Coal Research Laboratory		1,211
Irrigation Research Station, Merbein		
Development of Coomealla Block		894
Radiophysics		
Giant Radio Telescope		102,813
TOTAL Treasury Expenditure		**170,324**

Miscellaneous Services

	£
Contribution to Commonwealth Agricultural Bureaux ..	49,711
Grant to Standards Association of Australia	65,000
Contribution to Chair of Aeronautics at University of Sydney (establishment and maintenance)	5,000
Grant to National Association of Testing Authorities ..	15,125
National Institute of Oceanography	6,269
Minor International Associations	1,852
Australian and New Zealand Association for the Advancement of Science	1,643
	144,600

5

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Mr. C. R. Bunning, B.C.E.
Professor C. J. Birkett Clews, B.Sc., Ph.D.
Professor K. L. Cooper, B.Sc., M.A.
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Mr. A. J. Fraser
Dr. B. J. Grieve, M.Sc., Ph.D., D.I.C.
Mr. A. C. Harris, B.Sc.
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Mr. E. H. Lee-Steere
Sir Edward Lefroy, Kt.
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Professor H. H. Waring, M.Sc., D.Sc., F.A.A.
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STAFF

The following is a list of the professional staff of the Organization as at June 30, 1960

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Headquarters: 314 Albert Street, East Melbourne, Vic.

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Member of the Executive—S. H. Bastow, D.S.O., B.Sc., Ph.D.
Member of the Executive—R. N. Robertson, B.Sc., Ph.D., F.A.A.
Member of the Executive—C. S. Christian, B.Agr.Sc., M.S.
Member of the Executive—L. G. H. Huxley, M.A., D.Phil., Ph.D., F.A.A.
Secretary—G. B. Gresford, B.Sc., A.R.M.T.C.
Research Secretary—F. G. Nicholls, M.Sc. (*overseas*)
Executive Officer—W. Ives, M.Ec.
Secretary (Finance and Supplies)—M. G. Grace, A.A.S.A.
Assistant Secretary—P. F. Butler, M.Ag.Sc.
Assistant Secretary—D. T. C. Gillespie, M.Sc.
Senior Research Officer—W. M. Balding, B.Sc.
Senior Research Officer—W. F. Evans, B.Sc.
Experimental Officer—A. K. Klingender, B.Sc.
Experimental Officer—L. G. Wilson, M.Sc.
Senior Principal Research Officer—J. E. Cummins, M.Sc. (*overseas*)

Library

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Scientific Librarian—Miss M. L Cameron, B.Sc.
Scientific Librarian—Miss J. A. Conochie, B.Sc.
Scientific Librarian—Miss L. J. Davey, B.Sc.
Scientific Librarian—Miss H. M. Storie, B.Sc., F.R.M.T.C.
Librarian—Mrs. P. Cronshaw, A.L.A.
Librarian—Miss P. D. Prendergast, B.A.
Experimental Officer—Miss M. J. Dunstone, B.Sc., Dip.Ed.

Accounts

Accountant—D. J. Bryant, A.A.S.A.

Finance

Assistant Secretary (Finance and Supplies)—R. W. Viney, A.A.S.A., A.C.I.S.

Stock Records

J. M. Short, A.A.S.A., A.C.I.S.

Orders and Transport

V. H. Leonard, J.P.

Staff

Staff Relations Officer—L. G. Peres, B.Ec.
Senior Staff Officer—J. Coombe
Senior Registry Officer—P. Knuckey

Records

J. W. Graham (*acting*)

Publishing Section

T. R. Hunter

Liaison Overseas:

London

Chief Scientific Liaison Officer—E. J. Drake, F.R.A.C.I.
Principal Research Officer—F. Wilson

Washington

Chief Scientific Liaison Officer—T. B. Paltridge, B.Sc. (Hons.)

Translation Section

Translator-in-Charge—A. L. Gunn
Translator—E. Feigl, Ph.D.
Translator—Miss M. J. Hardy, B.A. (Hons.) (*at Sydney*)
Translator—Miss M. C. Harkins, B.A., M.A.
Translator—P. A. Kazakov, LL.B. (*at Sydney*)
Translator—Mrs. M. Slade
Translator—C. Wouters, Ph.D.(Lit.) (*at Sydney*)

Film Unit

Senior Research Officer—S. T. Evans, B.Sc.

Architect

Architect—W. R. Ferguson, B.E.

SECRETARIES OF STATE COMMITTEES

New South Wales

A. J. Higgs, B.Sc.(Hons.), Division of Radiophysics, University of Sydney

Victoria

Vacant

Queensland

W. W. Bryan, M.Sc.Agr., Cunningham Laboratory, Mill Road, St. Lucia, S.W.6, Qld.

South Australia

A. W. Peirce, D.Sc., Division of Biochemistry and General Nutrition, University of Adelaide

Western Australia

R. P. Roberts, M.Sc.(Agric.), Department of Agriculture, Perth

Tasmania

D. Martin, D.Sc., "Stowell", Stowell Avenue, Hobart

AGRICULTURAL RESEARCH LIAISON SECTION

Headquarters: 314 Albert Street, East Melbourne, Vic.

At Headquarters, East Melbourne

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Principal Research Officer—K. Loftus Hills, M.Agr.Sc.
Senior Research Officer—E. A. Jackson, B.Ag.Sc.
Senior Research Officer—Mrs. J. Tully, B.Sc. (Hons.), Ph.D.
Research Officer—J. J. Lenaghan, B.Agr.Sc., M.S.
Research Officer—G. F. Smith, M.A.
Experimental Officer—R. N. Farquhar, B.Agr.Sc., M.S. (*on leave*)
Experimental Officer—N. L. Tyshing, B.Sc.Agr.
Divisional Administrative Officer—K. L. Wells, B.A.
Librarian—Miss I. W. McNamara, B.A.

At Canberra

Principal Research Officer—D. V. Walters, M.Agr.Sc.
Research Officer—J. L. Dillon, B.Sc.Agr., Ph.D.
Experimental Officer—K. D. Woodyer, B.Sc.Agr.

At Sydney

Experimental Officer—R. E. Churchward, B.V.Sc., H.D.A.

ANIMAL RESEARCH LABORATORIES

DIVISION OF ANIMAL GENETICS

Headquarters: University of Sydney

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Assistant Divisional Secretary—A. B. Hackwell, B.Agr.Sc.

At Animal Genetics Laboratory, Sydney

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Senior Research Officer—D. F. Dowling, B.V.Sc., B.Sc., Ph.D.
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Research Officer—B. L. Sheldon, B.Sc.Agr. (Hons.)
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Experimental Officer—Miss N. Darveniza, B.Sc., Dip.Ed.
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At McMaster Field Station, Badgery's Creek, N.S.W.

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Research Officer—Y. S. Pan, M.Sc.Agr.

At National Field Station, "Gilruth Plains", Cunnamulla, Qld.

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Experimental Officer—M. T. Carpenter, B.Agr.Sc.

At National Cattle Breeding Station, "Belmont", Rockhampton, Qld.

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At Cattle Research Laboratory, Rockhampton, Qld.

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Experimental Officer—Miss J. E. Carey, B.Sc.

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At Animal Health Research Laboratory, Melbourne

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At Western Australian Department of Agriculture, Animal Health and Nutrition Laboratory, Nedlands, W.A.

Senior Research Officer—A. B. Beck, M.Sc.

At Institute of Agriculture, University of Western Australia, Nedlands, W.A.

Senior Research Officer—E. Munch-Petersen, M.Sc., B.A.

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Research Officer—B. A. Panaretto, B.V.Sc., Ph.D.

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At Parkville, Vic.

Principal Research Officer—R. H. Watson, D.Sc.Agr.

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Principal Research Officer—I. G. Jarrett, M.Sc.
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Senior Research Officer—R. A. Weller, B.Sc.
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Experimental Officer—V. A. Stephen
Administrative Officer—B. W. Bartlett

DIVISION OF BUILDING RESEARCH

Headquarters: Graham Road, Highett, Vic.

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Technical Secretary—J. R. Barned, B.Sc.
Divisional Editor—I. C. H. Croll, B.Sc.

Information and Library

Senior Research Officer—R. C. McTaggart, B.Sc.
Experimental Officer—E. M. Coulter, M.Ag.Sc.
Librarian—Miss L. W. Power

Mechanics and Physics of Materials

Principal Research Officer—F. A. Blakey, B.E. (Hons.), Ph.D.
Senior Research Officer—L. Finch, B.Arch., B.Sc., Ph.D.

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Experimental Officer—B. Kroone, Chem.Drs.
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Experimental Officer—B. C. Molony, A.F.T.C.
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Senior Research Officer—E. R. Segnit, M.Sc., Ph.D.
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Experimental Officer—Miss N. M. Rowland, F.R.M.T.C.

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Experimental Officer—C. J. Lancucki, B.Sc.

Surfacing Materials Investigations

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Principal Research Officer—W. K. R. Lippert, Dr.rer.nat.
Principal Research Officer—R. W. Muncey, M.E.E.
Principal Research Officer—A. F. B. Nickson, M.Sc.
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Experimental Officer—P. Dubout, B.Sc.
Experimental Officer—J. S. Howard, B.E.

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Research Officer—K. G. Martin, B.Sc.
Experimental Officer—N G. Brown, A.R.M.T.C.
Experimental Officer—J. W. Spencer, B.Sc.

Fibrous Plaster Investigations

Senior Research Officer—M. J. Ridge, M.Sc.
Experimental Officer—J. E. Bright, B.Sc.
Experimental Officer—H. Surkevicius, A.R.A.C.I.

Paint on Plaster Investigations

Senior Research Officer—E. Hoffmann, Dr.Phil.

Seconded to Australian Mineral Development Laboratories

Senior Research Officer—H. Ellerton, F.Inst. Ceram.

CANBERRA LABORATORIES, ADMINISTRATIVE OFFICE

The services of this office are common to the Divisions and Sections in Canberra

Senior Administrative Officer—K. J. Prowse, J.P.
Accountant—E. E. Petersen
Senior Librarian—P. Russell

CHEMICAL RESEARCH LABORATORIES

Headquarters: Lorimer Street, Fishermen's Bend, Vic.

Administration

Director—I. W. Wark, D.Sc., Ph.D., F.A.A.
Divisional Secretary—W. E. Ewers, M.Sc.
Assistant Divisional Secretary—R. J. Davidson, B.Sc.

Engineering

Divisional Engineer—J.B.Ross, B.Sc., A.R.M.T.C.
Experimental Officer—S. J. Attwood, Dip.Mech. Eng.

Library

Scientific Librarian—Miss B. M. Brown, B.Sc.

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Principal Research Officer—H. E. Vivian, B.Sc.Agr.
Principal Research Officer—G. F. Walker, Ph.D., D.Sc.
Principal Research Officer—L. S. Williams, D.Phil., B.E.
Senior Research Officer—K. M. Alexander, M.Sc., Ph.D.
Senior Research Officer—S. M. Brisbane, B.A., B.Sc., A.R.M.T.C.
Research Officer—G. M. Bruere, M.Sc.
Research Officer—J. Graham, M.Sc., Ph.D.
Research Officer—J. H. Taplin, B.Sc.(Hons.)
Experimental Officer—A. Adam, B.Chem.Eng.
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Experimental Officer—P. J. Darragh B.Sc.(Hons.)
Experimental Officer—C. E. S. Davis, B.Sc. (Hons.)
Experimental Officer—W. G. Garrett, A.R.M.T.C.
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Principal Research Officer—R. W. Urie, B.Sc., S.M.
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Senior Research Officer—A. B. Whitehead, B.Sc. (Hons.)
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Experimental Officer—C. J. Restarick, A.S.M.B.
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Experimental Officer—A. E. Perriman, B.Sc.

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Senior Research Officer—G. R. Hercus, M.Sc., D.Phil.
Senior Research Officer—A. J. C. Nicholson, M.Sc., Ph.D.
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Pasture Caterpillars and Taxonomy of Lepidoptera

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Biological Control

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Termites in Forest Trees

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Grain Storage Investigations

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Sheep Blowfly Ecology

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At Yeerongpilly, Qld.:

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At Ingham, Qld.:

Cattle Tick Investigations

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At Plant and Soils Laboratory, Brisbane:

Biological Control Investigations

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At Sydney:

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Experimental Officer—R. G. Lukins, B.Sc.

Fruit Fly Ecology (with University of Sydney)
Research Officer—M. A. Bateman, B.Sc., Ph.D.

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Senior Research Officer—K. Sheard, D.Sc.

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Principal Research Officer—A. G. Nicholls, B.Sc. (Hons.), Ph.D.
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Research Officer—W. Shepherd, B.Sc., B.Agr.Sc.
Research Officer—Dr. Beulah Simpson, B.Sc., Ph.D.
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Experimental Officer—Miss E. M. Christie, B.Sc.
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Senior Research Officer—J. H. B. Christian, B.Sc.Agr.(Hons.), Ph.D.
Senior Research Officer—W. G. Murrell, B.Sc.Agr., D.Phil.
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Experimental Officer—D. F. Ohye, D.I.C.

Experimental Officer—Miss J. A. Waltho, A.S.T.C., B.Sc.
Experimental Officer—A. D. Warth, M.Sc.

Biochemistry Investigations

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Senior Research Officer—J. B. Davenport, M.Sc. (*overseas*)

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Senior Research Officer—E. F. L. J. Anet, M.Sc., Ph.D.
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Experimental Officer—Miss D. E. Fenwick, A.S.T.C.

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Senior Research Officer—Miss J. M. Bain, M.Sc.

Canning and Fruit Products Section

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Senior Principal Research Officer—L. J. Lynch, B.Agr.Sc.(Hons.)
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Experimental Officer—W. A. Montgomery, A.S.T.C.

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Experimental Officer—F. S. Shenstone, A.S.T.C.

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Experimental Officer—J. H. Last, A.S.T.C.

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Experimental Officer—N. F. B. Tobin, B.Sc. (Hons.)

At Botany School, University of Melbourne:

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At Biochemistry School, University of Sydney:

Physical Chemistry Section

Experimental Officer—Miss J. F. Back, B.Sc., Dip.Ed.
Experimental Officer—M. B. Smith, B.Sc., A.S.A.S.M.

At National Standards Laboratory, University of Sydney:

Physical Methods Investigations

Experimental Officer—B. H. Kennett, A.S.T.C.

At Auburn, N.S.W.:

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Senior Research Officer—A. R. Prater, B.Sc.Agr.

At Sheep Biology Laboratory, Prospect, N.S.W.:

Muscle Biochemistry Investigations

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Experimental Officer—C. A. Lee, B.Sc.

At Atomic Energy Commission Research Establishment, Lucas Heights, N.S.W.:

Food Irradiation Investigations

Research Officer—J. J. Macfarlane, M.Sc.

At Tasmanian Regional Laboratory, Hobart:

Processing of Fruit and Vegetables

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Experimental Officer—R. A. Gallop, M.S., A.S.T.C. (*on leave*)

At Cannon Hill, Qld.:

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Principal Research Officer—W. E. Hillis, M.Sc., A.G.Inst.Tech.
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Research Officer—R. H. Vernon, M.Sc.
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NATIONAL STANDARDS LABORATORY

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The services shown hereunder are common to the Divisions of Metrology, Electrotechnology, and Physics, housed in the Laboratory at the University of Sydney

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Accountant—T. C. Clark, A.A.S.A.

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Experimental Officer—Mrs. C. R. Slater, B.Sc.Agr.

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Principal Research Officer—C. Barnard, D.Sc.

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Senior Research Officer—A. Steinbergs, Chem. (Eng.)
Senior Research Officer—D. J. David, M.Sc.
Experimental Officer—J. R. Twine, Dip.Ind. Chem.

Plant Nutrition
Senior Principal Research Officer—A. J. Anderson, D.Sc.Agr.
Senior Research Officer—J. F. Loneragan, B.Sc. (Hons.), Ph.D.
Senior Research Officer—K. D. McLachlan, B.Sc.Agr., B.Com.
Senior Research Officer—D. Spencer, B.Sc. (Hons.), Ph.D.
Research Officer—J. V. Possingham, B.Agr.Sc. (Hons.), M.Sc., D.Phil.
Experimental Officer—B. W. Norman, B.Sc.Agr.

Plant Biochemistry and Biophysics
Senior Principal Research Officer—J. E. Falk, M.Sc., Ph.D.
Principal Research Officer—C. G. Greenham, M.Sc.
Principal Research Officer—J. N. Phillips, M.Sc., Ph.D.
Senior Research Officer—N. K. Boardman, M.Sc., Ph.D.
Senior Research Officer—W. Bottomley, B.Sc. (Hons.), Ph.D.
Senior Research Officer—S. M. Bromfield, M.Agr.Sc., Ph.D.
Senior Research Officer—S. W. Thorne, B.Sc. (Hons.)
Senior Research Officer—P. A. Trudinger, B.Sc. (Hons.), Ph.D. (*overseas*)
Senior Research Officer—P. R. Whitfeld, B.Sc. (Hons.), Ph.D.
Research Officer—C. A. Appleby, B.Sc.(Hons.), Ph.D. (*overseas*)
Research Officer—N. A. Walker, B.Sc.(Hons.), Ph.D.
Experimental Officer—Mrs. M. B. Lowe, B.Sc. (Hons.)
Experimental Officer—R. J. Porra, B.Sc.(Hons.)

Plant Physiology
Senior Principal Research Officer—R. F. Williams, D.Sc.
Principal Research Officer—L. A. T. Ballard, M.A., M.Agr.Sc., Ph.D.
Senior Research Officer—L. T. Evans, B.Sc., M.Agr.Sc., D.Phil.
Senior Research Officer—N. P. Kefford, M.Sc., Ph.D.
Senior Research Officer—A. H. G. C. Rijven, B.Sc., Ph.D.
Research Officer—J. A. Zwar, M.Agr.Sc., Ph.D.
Experimental Officer—Miss A. E. Grant-Lipp, M.Sc.

Phytotron
Experimental Officer—L. J. Ludwig, B.Agr.Sc.
Experimental Officer—E. O'Neill, A.M.I.E.(Aust.)

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Principal Research Officer—A. B. Costin, B.Sc.Agr.(Hons.), M.Sc.
Principal Research Officer—C. W. E. Moore, M.Agr.Sc.
Senior Research Officer—E. F. Biddiscombe, M.Sc.Agr.
Senior Research Officer—R. W. Jessup, M.Sc.
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Research Officer—J. A. Carnahan, M.Sc.(Hons.), Ph.D.
Research Officer—P. W. Michael, B.Agr.Sc. (Hons.), Ph.D.
Experimental Officer—W. F. M. Straatmans, Dip.Agr., Dip.Trop.Agr.
Experimental Officer—J. D. Williams, D.D.A.
Experimental Officer—D. J. Wimbush, B.Sc. (*at Island Bend*)

Agricultural Physics
Principal Research Officer—J. R. Philip, B.C.E., D.Sc.
Research Fellow—N. E. Rider, B.Sc.(Hons.)
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Experimental Officer—A. J. Peck, B.Sc.(Hons.)

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Principal Research Officer—R. W. Prunster, B.Sc.Agr. (*seconded to the Commonwealth Bank*)
Principal Research Officer—W. M. Willoughby, B.Sc.Agr.
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Research Officer—G. W. Arnold, M.Sc.Agr.
Research Officer—J. Lipsett, B.Agr.Sc.(Hons.)
Research Officer—J. R. Simpson, M.Sc., Ph.D.
Experimental Officer—N. T. Clark, B.Rur.Sc.

At Regional Pastoral Laboratory, Armidale, N.S.W.:

Pasture Investigations
Principal Research Officer—R. Roe, B.Sc.Agr.
Senior Research Officer—E. J. Hilder, B.Sc.Agr.
Senior Research Officer—K. Spencer, B.Sc.Agr. (Hons.), M.S.
Research Officer—N. J. Barrow, M.Agr.Sc., Ph.D.

Research Officer—J. R. Freney, M.Sc.
Research Officer—J. L. Wheeler, B.Sc., Ph.D.
Experimental Officer—R. E. Mottershead, B.Sc.
Experimental Officer—J. A. Thompson, B.Sc. (For.)

At Regional Pastoral Laboratory, Deniliquin, N.S.W.:

Officer-in-Charge—L. F. Myers, M.Agr.Sc.

Pasture Investigations

Senior Research Officer—O. B. Williams, M.Agr.Sc.
Research Officer—J. L. Davidson, M.Agr.Sc.
Research Officer—C. R. Kleinig, M.Agr.Sc. (Hons.)
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At Regional Laboratory Perth:

Officer-in-Charge—R. C. Rossiter, B.Sc.Agr., D.Sc.(Agric.)

Pasture Investigations

Senior Research Officer—A. W. Humphries, B.Sc.Agr.(Hons.)
Senior Research Officer—P. G. Ozanne, B.Sc.Agr.
Research Officer—H. L. Davies, B.Sc.Agr.(Hons.)
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Plant Introduction

Senior Research Officer—E. T. Bailey, B.Sc. (Hons.)

At "Glen Lossie" Field Station, Kojonup, W.A.:

Pasture Investigations

Senior Research Officer—E. R. Watson, M.Sc.Agr.
Experimental Officer—P. Lapins, Dip.Agronom., M.Ag.Sc.

At Tasmanian Regional Laboratory, Hobart:

Fruit Investigations

Principal Research Officer—D. Martin, D.Sc.
Research Officer—T. L. Lewis, M.Sc. (*overseas*)
Experimental Officer—J. Cerny, Dr.Tech.Sc.

At Applethorpe, Qld.:

Fruit Investigations

Principal Research Officer—L. A. Thomas, M.Sc.

At University of Melbourne:

Mineral Nutrition Investigations

Principal Research Officer—L. H. P. Jones, B.Agr.Sc., Ph.D.

At University of Queensland, Brisbane:

Rain Forest Ecology

Principal Research Officer—L. J. Webb, M.Sc., Ph.D.

At Tobacco Research Institute, Mareeba, Qld.:

Director—D. W. Goodall, Ph.D., D.Sc.
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Research Officer—P. J. Goodman, B.Sc.(Hons.), Ph.D.
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DIVISION OF RADIOPHYSICS

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Senior Research Officer—J. A. Roberts, M.Sc., Ph.D.
Research Officer—A. G. Little, B.Sc.
Research Officer—D. S. Mathewson, M.Sc.
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On Secondment

Experimental Officer—G. A. Chandler, B.E.

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Research Officer—N. C. Donovan, B.E.(Hons.), M.S.E., Ph.D.
Experimental Officer—P. O. Morris, B.C.E.
Experimental Officer—B. G. Richards, B.E.

DIVISION OF SOILS

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At Adelaide:

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Administrative Officer—F. W. Blanksby
Librarian—P. H. Dawe

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Principal Research Officer—G. Blackburn, B.Ag.Sc.
Principal Research Officer—K. H. Northcote, B.Ag.Sc.
Research Officer—G. G. Beckmann, M.Sc.
Research Officer—W. H. Litchfield, B.Sc.Agr. (*at Alice Springs*)
Research Officer—C. B. Wells, M.Ag.Sc. (*overseas*)

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Principal Research Officer—J. T. Hutton, B.Sc., A.S.A.S.M.
Principal Research Officer—A. C. Oertel, M.Sc.
Senior Research Officer—M. Raupach, M.Sc.
Senior Research Officer—H. C. T. Stace, M.Sc.
Senior Research Officer—B. M. Tucker, B.A., M.Sc.
Research Officer—K. G. Tiller, M.Sc. (*study leave*)
Experimental Officer—R. D. Bond, B.Tech.
Experimental Officer—A R. P. Clarke, A.S.A.S.M.
Experimental Officer—J. B. Giles, B.Sc.
Experimental Officer—R. M. McKenzie, B.Tech.
Experimental Officer—M. P. C. de Vries (l.i.)

Soil Physics Section

Senior Principal Research Officer—T. J. Marshall, M.Ag.Sc., Ph.D.
Senior Research Officer—W. W. Emerson, B.A., Ph.D.
Senior Research Officer—E. L. Greacen, B.Sc.Agr., Ph.D.
Senior Research Officer—J. W. Holmes, M.Sc.
Research Officer—A. V. Blackmore, M.Sc., Ph.D.

Research Officer—J. S. Colville, M.Sc.
Research Officer—C. G. Gurr, B.Sc.

Soil Microbiology Section
Senior Principal Research Officer—R. J. Swaby, M.Sc., M.Ag.Sc., Ph.D.
Senior Research Officer—J. R. Harris, M.Sc.
Research Officer—G. D. Bowen, B.Sc.
Research Officer—J. N. Ladd, M.Sc., Ph.D.
Research Officer—A. D. Rovira, B.Ag.Sc., Ph.D.
Experimental Officer—P. G. Brisbane, B.Sc.Agr.
Experimental Officer—Mrs. J. I. Rogasch, B.Sc.

Mineralogy Section
Senior Research Officer—K. Norrish, M.Sc., Ph.D.
Research Officer—E. W. Radoslovich, M.Sc., Ph.D.
Research Officer—J. A. Rausell Colom, D.Sc.
Experimental Officer—T. R. Sweatman, B.Sc.
Experimental Officer—R. M. Taylor, B.Sc.

At Brisbane:

Soil Survey and Pedology Section
Principal Research Officer—G. D. Hubble, B.Ag.Sc.
Research Officer—R. F. Isbell, M.Sc.
Research Officer— C. J. de Mooy (l.i.)
Experimental Officer—C. H. Thompson, Q.D.A.

Soil Physics Section
Senior Research Officer—G. B. Stirk, B.Sc.
Experimental Officer—R. E. Prebble, B.Sc.

Soil Chemistry Section
Principal Research Officer—A. E. Martin, D.Sc.
Senior Research Officer—R. S. Beckwith, B.Sc.
Experimental Officer—I. F. Fergus, B.Sc.
Experimental Officer—I. P. Little, B.Sc.Agr.
Experimental Officer—R. Reeve, Dip.Ind.Chem.

Micropedology
Experimental Officer—B. F. Breese, B.Sc.

At Canberra:

Soil Survey and Pedology Section
Senior Principal Research Officer—B. E. Butler, B.Sc.(Agric.)
Senior Research Officer—D. C. van Dijk, Ing.Agr., D.Sc.
Research Officer—J. A. Beattie, B.Sc.Agr. (*study leave*)
Research Officer—J. Loveday, M.Ag.Sc., Ph.D. (*at Griffith*)
Research Officer—W. M. McArthur, B.Sc. (*at Armidale*)
Research Officer—P. H. Walker, M.Sc.Agr. (*at Sydney*)

Soil Chemistry Section
Senior Research Officer—J. D. Colwell, B.Sc.Agr., Ph.D.
Experimental Officer—H. J. Beatty, Dip.Ind. Chem.

Soil Physics Section
Research Officer—D. S. McIntyre, M.Sc., Ph.D.

Soil Micropedology Section
Principal Research Officer—R. Brewer, B.Sc.
Senior Research Officer—J. R. Sleeman, B.Ag.Sc.
Experimental Officer—Miss M. P. Green, B.Sc.

Administration
Administrative Officer—R. W. Tracey

At Hobart:

Soil Survey and Pedology Section
Principal Research Officer—K. D. Nicolls, B.Ag.Sc., B.Sc.
Research Officer—G. M. Dimmock, B.Sc.

Soil Chemistry Section
Experimental Officer—A. M. Graley, B.Sc.
Experimental Officer—J. L. Honeysett, B.Sc.

At Perth:

Soil Survey and Pedology Section
Senior Research Officer—M. J. Mulcahy, B.Sc.
Research Officer—H. M. Churchward, B.Sc.Agr. (Hons.)
Experimental Officer—E. Bettenay, M.Sc.(Agric.)

Soil Chemistry Section
Experimental Officer—F. J. Hingston, B.Sc.
Experimental Officer—A. G. Turton, B.Sc.

DIVISION OF TRIBOPHYSICS

Headquarters: University of Melbourne

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Administrative Officer—W. A. Daunt
Principal Research Officer—L. M. Clarebrough, Ph.D., B.Met.E., M.Eng.Sc.
Principal Research Officer—M. E. Hargreaves, Ph.D., B.Met.E.
Principal Research Officer—A. K. Head, Ph.D., B.A.(Hons.), B.Sc.
Principal Research Officer—J. K. Mackenzie, Ph.D., B.A.(Hons.), B.Sc.
Principal Research Officer—A. J. W. Moore, Ph.D., B.Sc.
Senior Research Officer—A. J. Davis, B.Eng.
Senior Research Officer—D. Michell, B.E.E.
Senior Research Officer—J. F. Nicholas, B.A. (Hons.), B.Sc.
Senior Research Officer—G. J. Ogilvie, Ph.D., B.Met.E., M.Eng.Sc.
Senior Research Officer—J. V. Sanders, Ph.D., B.Sc.(Hons.)
Senior Research Officer—J. A. Spink, M.Sc.
Senior Research Officer—G. W. West, B.E.E., B.Sc.
Research Officer—J. G. Allpress, M.Sc.(Hons.)
Research Officer—J. Bagg, Ph.D., B.Sc.
Research Officer—Mrs. L. A. Bruce, Ph.D., B.Sc. (Hons.)

Research Officer—E. A. Faulkner, M.A.(Hons.)
Research Officer—P. G. Fox, Ph.D., B.Sc.
Research Officer—R. K. Ham, Ph.D., B.A.Sc.
Research Officer—D. F. Klemperer, Ph.D., B.Sc.
Research Officer—M. H. Loretto, B.Met.(Hons.)
Research Officer—H. G. Scott, Ph.D., B.Sc.
Experimental Officer—H. Jaeger, A.R.A.C.I.
Experimental Officer—R. R. Johnston, Dip. Appl.Chem., B.Sc.
Experimental Officer—N. H. Ladizesky, B.Sc.
Experimental Officer—R. M. Lowe, B.Sc.
Experimental Officer—G. R. Perger, F.R.M.T.C.
Experimental Officer—R. G. Sherwood, A.R.M.T.C.
Experimental Officer—A. A. Thomson, A.R.M.T.C.
Experimental Officer—A. J. White, A.R.M.T.C.

DIVISION OF TROPICAL PASTURES

Headquarters: Cunningham Laboratory, St. Lucia, Qld.

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Laboratory Secretary—A. G. Eyles, B Sc. (Agric.)

Agrostology

Chief—J Griffiths Davies, Ph.D., D.Sc.
Principal Research Officer—W. W. Bryan, M.Agr.Sc.
Principal Research Officer—N. H. Shaw, B.Agr.Sc.(Hons.)
Research Officer—L. A. Edye, B.Agr.Sc.(Hons.)
Research Officer—F. K. van der Kley, D.Ag.Sc.
Research Officer—L. 't Mannetje, Ir.
Research Officer—J. J. Yates, B.Sc.(Agric.) (Hons.)
Experimental Officer—N. L. Wilson, B.Agr.Sc.

Plant Breeding and Genetics

Senior Principal Research Officer—E. M. Hutton, B.Agr.Sc., D.Sc.
Research Officer—A. J. Pritchard, B.Sc.(Hons.)
Experimental Officer—D. E. Byth, B.Agr.Sc.
Experimental Officer—S. G. Gray, M.Sc.Agr.

Plant Nutrition and Soil Fertility

Principal Research Officer—C. S. Andrew, M.Agr.Sc.
Research Officer—E. F. Henzell, B.Agr.Sc. (Hons.), Ph.D.

Plant Physiology

Senior Research Officer—R. G. Coleman, B.Sc.Agric., D.I.C., Ph.D.
Senior Research Officer—C. T. Gates, M.Sc. (Agric.)

Plant Chemistry

Research Officer—M. P. Hegarty, M.Sc., Ph.D.
Experimental Officer—R. D. Court, B.Sc.
Experimental Officer—Miss P. M. Thorne, B.Sc.

Ecology

Senior Research Officer—J. E. Coaldrake, M.Sc.
Experimental Officer—W. F. Ridley, M.Sc.

Legume Bacteriology

Senior Principal Research Officer—D. O. Norris, D.Sc.(Agric.)

Pasture Evaluation and Animal Nutrition

Research Officer—R. Milford, B.Agr.Sc.(Hons.)

UPPER ATMOSPHERE SECTION

Headquarters: Harben Vale, Camden, N.S.W.

Officer-in-Charge—D. F. Martyn, D.Sc., Ph.D., F.A.A., F.R.S.
Senior Research Officer—G. R. A. Ellis, B.Sc., Ph.D.
Research Officer—R. A. Duncan, B.Sc.(Hons.)
Experimental Officer—D. G. Cartwright, B.Sc. (Hons.)
Experimental Officer—T. W. Davidson, M.Sc.

WESTERN AUSTRALIAN REGIONAL LABORATORY

The services of this office are common to Divisions and Sections represented in Western Australia

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Administrative Officer—J. P. Brophy
Scientific Librarian—Miss J. C. Kahan, B.Sc.

WHEAT RESEARCH UNIT

Headquarters: Delhi Road, North Ryde, N.S.W.

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Leader of Unit—M. V. Tracey, M.A.
Senior Research Officer—J. Wilson Lee, B.Sc. (Hons.), Ph.D.
Research Officer—D. J. Winzor, B.Sc.(Hons.)
Experimental Officer—Miss P. M. Bell, B.Sc.
Experimental Officer—J. K. Raison, A.S.T.C.

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Headquarters: Canberra

At Canberra

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Sectional Secretary—F. N. Robinson, B.A.
Administrative Officer—P. Magi
Principal Research Officer—H. J. Frith, B.Sc.Agr.
Principal Research Officer—M. E. Griffiths, D.Sc.

Senior Research Officer—J. H. Calaby, Dip.App. Chem.
Senior Research Officer—A. L. Dyce, B.Sc.Agr. (Hons.)
Research Officer—R. Mykytowycz, B.V.M., D.V.M.
Experimental Officer—J. M. MacLennan, M.A., B.Sc., Ph.D.
Experimental Officer—I. C. R. Rowley, B.Agr.Sc.
Scientific Librarian—Mrs. E. M. Wylie, B.Sc.

At Perth

Principal Research Officer—D. L. Serventy, B.Sc. (Hons.), Ph.D.
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Experimental Officer—S. J. J. Davies, B.A. (Hons.)

At Albury, N.S.W.

Research Officer—W. E. Poole, B.Sc.(Hons.)
Experimental Officer—J. S. Hayward, B.Sc. (Hons.)

At Armidale, N.S.W.

Senior Research Officer—B. V. Fennessy, B.Agr.Sc.
Experimental Officer—J. E. Bromwell, B.Agr.Sc.

At Hobart

Research Officer—M. Ridpath, B.Sc.(Hons.)

At Adelaide

Senior Research Officer—K. Myers, B.Sc.(Hons.)

WOOL RESEARCH LABORATORIES

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Senior Principal Research Officer—H. Lindley, B.A., Ph.D.
Principal Research Officer—R. D. B. Fraser, Ph.D.
Principal Research Officer—J. M. Gillespie, M.Sc.
Principal Research Officer—M. A. Jermyn, M.Sc., Ph.D.
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Principal Research Officer—T. A. Pressley, B.Sc.
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Principal Research Officer—E. O. P. Thompson, M.Sc., Dip.Ed., Ph.D.
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Senior Research Officer—G. E. Rogers, M.Sc., Ph.D.
Senior Research Officer—W. E. Savige, Ph.D.
Research Officer—T. P. MacRae, M.Sc.
Research Officer—B. Milligan, Ph.D.
Research Officer—C. M. Roxburgh, Ph.D.
Research Officer—P. H. Springell, M.A., Ph.D.
Research Officer—G. Youatt, Ph.D.
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Experimental Officer—G. F. Flanagan, Dip.Appl. Phys., F.R.M.T.C.
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Experimental Officer—R. J. Rowlands, B.Sc.
Experimental Officer—I. W. Stapleton, Dip. Chem., B.Sc.
Experimental Officer—K. I. Wood, A.R.M.T.C.

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Principal Research Officer—G. W. Walls, B.Sc.
Senior Research Officer—J. H. Bradbury, M.Sc., Ph.D.
Senior Research Officer—J. R. McPhee, B.Sc., Ph.D.
Senior Research Officer—W. V. Morgan, B.Sc.
Senior Research Officer—D. S. Taylor, B.A., B.Sc., Ph.D.
Senior Research Officer—T. Topham, A.T.I. (*seconded to Australian Wool Bureau*)
Senior Research Officer—G. F. Wood, B.Sc., Ph.D.
Research Officer—C. A. Anderson, B.Sc., Ph.D.
Research Officer—R. E. Belin, M.Sc.
Research Officer—J. Delmenico, B.Sc. (*overseas*)
Research Officer—D. E. Henshaw, B.Sc.
Research Officer—V. A. Williams, B.Sc., Ph.D.
Experimental Officer—B. B. Beard, A.G.Inst. Tech.
Experimental Officer—A. J. Van Heel, B.Sc.
Experimental Officer—M. A. Higgins, A.G.Inst. Tech. (*seconded to Australian Wool Bureau*)
Experimental Officer—B. O. Lavery, Nat. Cert. in Mech. Eng.
Experimental Officer—A. R. W. Lee, B.Sc., Dip.Ed.
Experimental Officer—J. D. Leeder, A.G.Inst. Tech.

Experimental Officer—D. C. Shaw, B.Sc. (*overseas*)
Experimental Officer—G. C. West, A.G.Inst. Tech.

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Senior Principal Research Officer—G. H. Munro, D.Sc. (*seconded to Electrical Engineering Department, University of Sydney*)
Principal Research Officer—J. C. M. Fornachon, B.Agr.Sc., M.Sc. (*seconded to Australian Wine Research Institute*)
Research Officer—H. M. Radford, B.Sc. (*on leave*)
Experimental Officer—L. Heisler, B.Sc. (*seconded to Electrical Engineering Department, University of Sydney*)
Experimental Officer—J. N. Stephens, M.A. (*on leave*)
Experimental Officer—W. R. Stern, B.Agr.Sc., M.Sc. (*on leave*)
Experimental Officer—P. R. Strutt, B.Sc. (*on leave*)